

NORTH AMERICAN PARASITIC COPEPODS BELONGING  
TO THE FAMILY CALIGIDÆ.

PART 2.—THE TREBINÆ AND EURYPHORINÆ.

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INTRODUCTION.

This fourth paper in the series based upon the collection belonging to the United States National Museum is really a continuation of the third, which was published in Vol. XXVIII of these Proceedings.

It takes up the second and third subfamilies of the Caligidæ and includes the five species belonging to these subfamilies which have thus far been found in North American waters and three which are foreign, but at the same time are represented in the Museum collection.

Of the five native species one, *Dysgamus arionmus*, is new to science; the others have been described elsewhere, but three of them, *Gloiopotes ornatus*, *Alabion gracilis*, and *Alabion glaber*, have never before been figured.

In conformity with the policy adopted for this series of papers, the artificial keys under the subfamilies and genera, which are here for the first time presented, are made to include all the known genera and species, respectively.

Since both the subfamilies here treated are new to science, their ontogeny is also new. This is especially true of the continuous life-history of the genus *Alabion*, with the figures of its metanauplius and the anatomical details of the latter, upon which is based the *raison d'être* of the subfamily Euryphorinæ.

Subfamily TREBINÆ.

Sexes similar as in the Caliginæ. First and second thorax segments united with the head to form a broad and flattened carapace. The various regions on the dorsal surface separated by distinct grooves arranged differently from those in the other subfamilies. Third and fourth segments free and without dorsal plates or any appendages

except the thoracic legs. Genital segment enlarged, but never much more than half the size of the carapace. Abdomen elongate; anal laminae long and narrow. Furca and first maxillae both present. All the swimming legs biramose; rami of first pair two-jointed, of the other pairs three jointed, except in *evilis*, where the fourth pair has a two-jointed endopod. Egg strings as in the Caliginæ. Adults active, both sexes swimming about freely. The young reported by Krøyer (1863) and Olsson (1869) to pass through a chalimus stage in which they are attached by a frontal filament, the remains of which can be plainly seen in the median incision of the frontal plates in later stages of development (fig. 2).

This subfamily stands as a connecting link between the Caliginæ and the Euryphorinæ. In its development it is almost identical with the Caliginæ, but in its morphology it is radically different from them and more closely resembles the Euryphorinæ, though differing from the latter also in many important particulars. At present it is composed of the single genus *Trebius*.

It would seem at first as if this genus could be included either with the Caliginæ or the Euryphorinæ, rather than separated from them both.

Krøyer, Steenstrup and Lütken, and Heller place it with the Caliginæ, while Gerstaecker puts it with his "Nogagina" (Euryphorinæ). The following considerations have seemed sufficient to the author to warrant its separation in a subfamily by itself:

A. If it were included with the Caliginæ—

1. It would be the only genus having more than a single free thorax segment. In all the other genera the three anterior segments of the thorax are fused with the head to form a carapace, which has the same general shape in every genus and the same arrangement of grooves and areas. Moreover, the fusion is complete, and despite the grooves there is very little motion, if any, between the different areas. Here in *Trebius* only two thorax segments are fused with the head, and there are several important differences in the grooves and areas.

For instance, the thoracic area, which in the Caliginæ includes the three anterior thoracic segments, is here restricted to the second segment alone and has been so much shortened as to become transversely semilunar. Again, the grooves separating the lateral areas extend forward to the very bases of the first antennæ, a condition found in none of the Caliginæ.

The short transverse grooves also which separate the cephalic from the thoracic portions of the lateral areas extend to the very edge of the carapace and form there well-defined notches or incisions. But more than all this, the fusion of the different areas is not so complete as to prevent considerable freedom of motion along the various grooves. This is especially true of the second thorax segment, which,

despite its attachment to the carapace, possesses considerable freedom of motion.

2. It would be the only genus in which all the legs were biramose. This objection has greater value when we find that the third legs, which are always biramose, show a marked resemblance to those of the Euryphorinæ, and are very different from those of the Caliginæ. Krøyer,<sup>a</sup> in his original description of the genus, notes that the first, third, and fourth legs differ markedly from those of the Caliginæ. But he says that the second legs correspond in the smallest details with those of *Caligus*. "Fjerde<sup>b</sup> par Fødder er indtil de mindste Detaillen som has Slaegten *Caligus*."

His statement would have been more accurate had he substituted the genus *Lepeophtheirus* for *Caligus*. In *Caligus* the spines on the outer margin of the exopod in these second legs are large and almost invariably turn inward and run diagonally across the ramus, while in *Lepeophtheirus* they are smaller and are parallel with the margin, as we find them here.

3. The eyes, which are very small and easily overlooked in the adult, are separate, one on either side of the mid-line, and are not fused, as in the Caliginæ.

4. The mouth tube, while it has not become as long and pointed as in some of the Euryphorinæ (*Albion* and *Gloiopotes*), is yet noticeably longer and narrower than in the Caliginæ, and is also definitely jointed near the base. The side incisions at the joint are deeper than usual, and the corners are more prominent, as was noted by Krøyer. In short, the mouth and the mouth-parts are as symmetrically intermediate between the types of the Caliginæ and the Euryphorinæ as could well be desired.

B. On the other hand, if it were included with the Euryphorinæ—

1. It would still be peculiar in having two free thorax segments and also in the arrangement of the grooves and areas on the dorsal surface of the carapace. While the fusion of the head and thorax segments is not as complete in the Euryphorinæ as in the Caliginæ, it is still thorough enough to effectually prevent any such freedom of movement as we find here.

2. It has no dorsal plates on the free thorax, the genital segment, or the abdomen. This, of course, would not count for much if it were the only difference, but it does contribute materially in the way of cumulative evidence.

3. It would be the only genus in which the larva was attached during the chalimus stage by means of a frontal filament like those found

<sup>a</sup>Om Snyltekrebsene, især med Hensyn til Danske Fauna, 1838, pp. 32-34.

<sup>b</sup>He calls the first maxillipeds the "first pair of legs," and hence his "fjerde," or fourth pair, would be really the second swimming legs.

in the Caliginæ. This is the most important difference, and furnishes, in the author's opinion, a sufficient reason for excluding the genus from the Euryphorinæ.

Genus TREBIUS Krøyer.

Carapace usually oval or elliptical and quite strongly arched dorsally. Third thorax segment short and wide; free, but attached to the posterior margin of the carapace in such a way as to complete a thoracic area somewhat like that in the Caliginæ. The grooves, however, are arranged differently and consist of a semiellipse at the posterior end of the carapace, a longitudinal groove on either side extending forward to the lateral sinus behind the base of the first antenna, and a transverse groove extending outward on either side from this longitudinal groove to a notch in the edge of the carapace.

The body of the copepod is capable of more motion along these grooves, particularly the semiellipse, than in the genera of the Caliginæ.

Fourth segment more or less elongate, abruptly narrowed anteriorly and posteriorly, with its sides projecting strongly at the center over the bases of the fourth legs.

Genital segment considerably smaller in the male and showing two pairs of legs, one on the sides and the other at the posterior corners. Egg-strings as in *Caligus*; eggs small and numerous.

Mouth-tube long and wide and distinctly hinged at the center; mouth-opening terminal and heavily fringed with hairs.

Mandibles slender, slightly curved, and toothed on the inner margin only. Second maxillæ long and pointed, articulate; either simple or slightly bifurcate at the tips. First maxillipeds stouter and the second pair weaker than in the Caliginæ, thus eliminating much of the difference between the two appendages.

(*trebius*, the name of a parasite in Juvenal, Satire V.)

ONTOGENY.

The life history of this genus is very similar, so far as known, to that of the Caliginæ. The following summary is taken from the works of various authors, chiefly Krøyer (1863) and Olsson (1869), supplemented by original research:

Nothing is known of the nauplius and metanauplius stages; the youngest individual so far obtained was a small chalimus found by Krøyer amongst the preserved material he examined. But this chalimus is so similar to those found among the Caliginæ as to leave little doubt that the earlier stages are equally similar, and that when found they will differ simply in detail and not in any of the essential characters.

Krøyer's chalimus specimen (fig. 1) was about 1.5 mm. long and of an elongated oval form. Carapace two-fifths the entire length, as wide as

long, evenly rounded anteriorly, slightly narrowed and emarginate posteriorly. The dorsal surface of this carapace shows no grooves at all, which would naturally be expected since there is no fusion as yet between the head and thorax, neither have the segments formed any lobes or processes.

Frontal plates small but distinct: antennae slender but proportionally long, their tips reaching beyond the lateral margins of the carapace. Eyes small, some little distance apart on either side of the mid-line and just in front of the center of the carapace. This separation of the eyes from the earliest known stage is a notable departure from the condition in the *Caligina*. In the latter the eyes are fused from the beginning of the metanauplius stage<sup>a</sup>. Indeed in the preceding nauplius stage whenever the eyes are visible they are fused on the mid-line<sup>b</sup>. This suggests that the characteristic median eye of the nauplius larva may be a more complete fusion of two eyes.

The first three segments of the thorax are free, of about the same length, but diminish a little in width from in front backward.

The first one is the same width as the carapace, and each of the three carries a pair of more or less rudimentary swimming legs. Kröyer represents all three pairs as uniramous, the first and third pairs two-jointed, the second pair three-jointed.

He says nothing about these swimming legs in the text, so that we

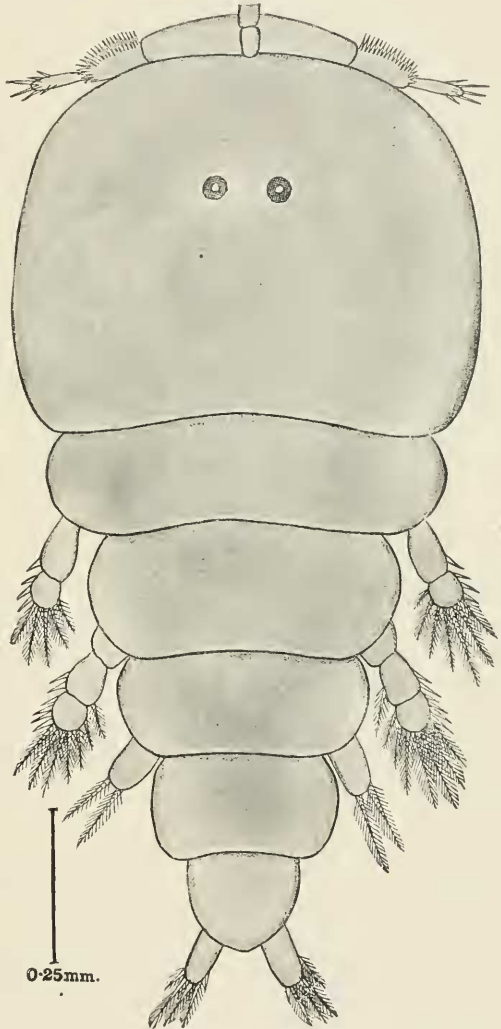


FIG. 1.—*CHALIMUS* OF *TREBIUS CAUDATUS* (AFTER KRÖYER).

<sup>a</sup> Proc. U. S. Nat. Mus., XXVIII, 1905, p. 541, fig. 40.

<sup>b</sup> *Idem*, fig. 39.

are compelled to fall back upon his figure, which is a fairly good one, for our information. That the three pairs are all uniramous, is extremely improbable, and Olsson's description must be received as much the more accurate.

This latter author says, in speaking of the smallest chalimus found (0.8 mm. long), that it possessed two pairs of swimming legs, each with a single basal joint, and two one-jointed rami.

A little larger specimen (1.2 mm. long) showed vestiges of the third legs, while a larva two millimeters long had all the "abdominal feet," but the rami, except those of the first pair, were not jointed.<sup>a</sup> This corresponds with the condition in the Caliginæ and Euryphorinæ and hence is what would naturally be expected for the present genus.

The fourth segment is still fused with the genital segment, and the two bear no appendages. The abdomen consists of a single short and wide joint bearing the small and elongate anal laminae. These last two joints also diminish regularly in size from the third thorax joint, so that the whole posterior body of the chalimus tapers evenly toward the abdomen.

The second antennæ are noticeably elongated and slender; the two joints are about the same size, while the terminal claw is short and abruptly bent over toward the second joint into the form of a sharp hook. Nothing is said of the other appendages save that the mouth-parts have the same general shape and arrangement as in the adult. In fact they furnish in this one of the best evidences of the identity of the larva.

In this young chalimus, for such it is proved to be by the stump of a frontal filament still attached to the frontal plates, the transverse groove between the head and first thorax segment is perfectly straight, while that between the first and second thorax segments is slightly curved forward at the center.

This forward curve is increased in later development, so that on a larva 2.5 mm. long it projects quite a little way into the posterior portion of the carapace (fig. 2).

This larva and the one following, the next two stages known, were found by the author among some adults of *Trebis exilis*, a new species obtained by Prof. W. A. Herdman from *Rhinoptera javanica* at Ceylon. The lateral processes on the sides of the second segment in this larva are nearly as large as the posterior lobes of the carapace. The third segment is considerably narrower than the second, but is still wider than it is long. The fourth and genital segments have been separated; the former has been elongated until it is now longer than wide and is of a broad spindle shape, widest at the center.

The genital segment has a curious shape; each of the posterior angles projects strongly sidewise, is well rounded, and armed with two

<sup>a</sup>Olsson, Prodrömus faunæ Copepodorum parasitantium Scandinaviæ, 1869, p. 15.

stout spines. This makes the segment nearly twice as wide across its posterior margin as at the anterior end.

In fig. 2 a short segment can be seen immediately behind the fourth segment and in front of the genital segment proper. This short segment bears the rudiments of a pair of legs at its posterior corners, but it is not fully separated from the genital segment. There is simply the position of these rudimentary legs and a deep lateral incision on either side just behind them to indicate the posterior limit of the segment. There is no groove across the median line on either the dorsal or ventral surface. These rudimentary fifth legs subsequently disappear entirely in the female, but are retained in the male, and appear in the adult on the sides of the genital segment two-thirds of its length from the anterior end.

In other words, what is ordinarily termed the genital segment is really a fusion of two segments, the fifth and sixth, of which the fifth forms more than half.

The abdomen has lengthened and become longer than wide; it also is slightly wider at its posterior end, and the anal laminae have become twice as long as wide.

All four pairs of legs are now present and all are biramose, but the rami have only two joints instead of three.

The frontal plates have thickened considerably, but in the sinus between them can still be seen the remnants of the frontal filament. The antennae are relatively much shorter and thicker than before, and

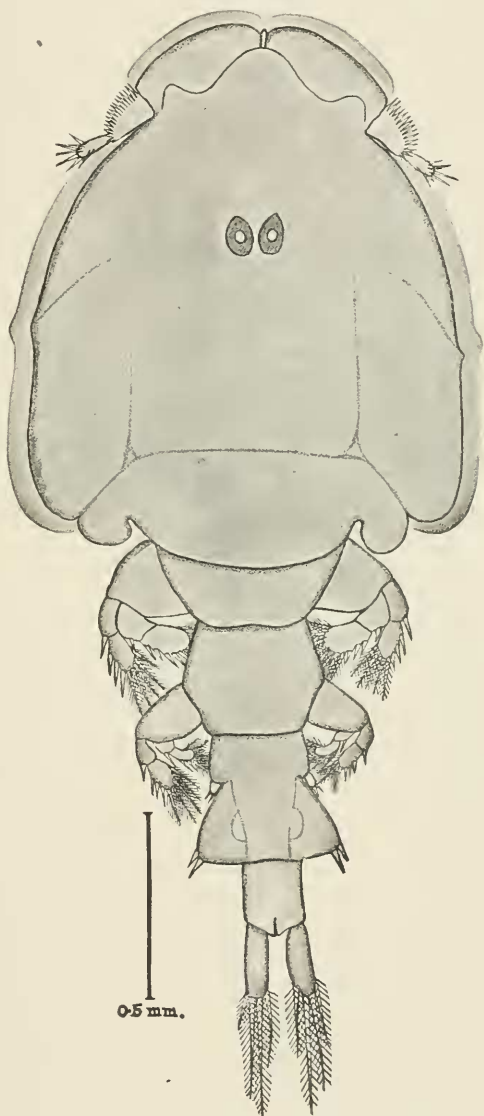


FIG. 2.—LARVA OF TREBIUS EXILIS, 2.5 MM. LONG.

are appressed more closely to the margin of the carapace. The eyes have approached nearer together but are still not fused, although they are nearly in contact with each other. The dorsal surface of the carapace shows the single posterior groove between the first and second segments, the beginnings of the lateral longitudinal grooves, and the transverse grooves dividing the lateral areas. Otherwise the surface is smooth and without markings. The general appearance of this larva is so radically different from that of the adult that at first it was supposed they were separate species. But there is no difference to be detected in any of the appendages save the swimming legs, where, as already stated, the rami have but two joints instead of three.

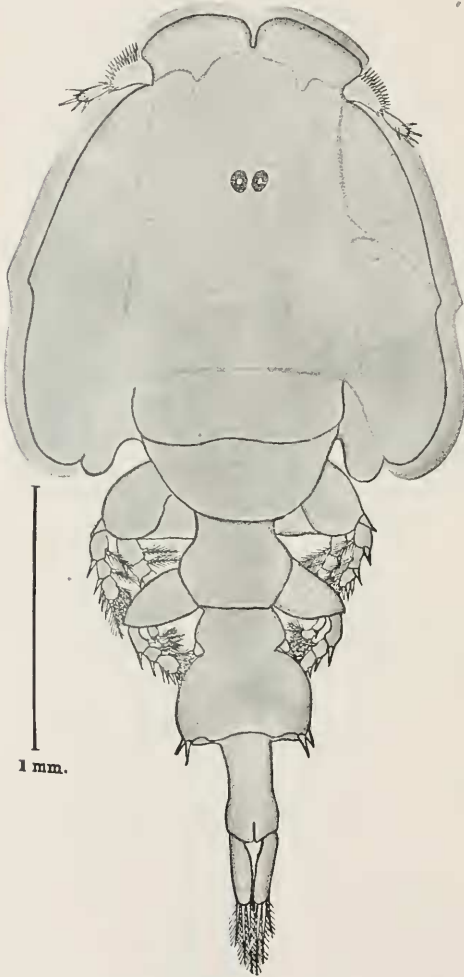


FIG. 3.—LARVA OF TREBIUS EXILIS, 3.5 MM. LONG.

Another young female, the second of the larvæ obtained from Ceylon, measured 3.5 mm. in length. At this stage the carapace has enlarged even more, being now five-sevenths of the entire length (fig. 3). The second thorax segment has widened with the carapace and also shortened somewhat. It still projects with a shallow and uniform curve into the posterior portion of the carapace and is nearly

This, however, is only another evidence of the larval condition and not one of specific difference. Krøyer, in his second account of the genus, called attention to the very diverse modifications of form among the females, which he declared could be referred with certainty<sup>a</sup> to the different degrees of development. He also inferred that the females of *caudatus* do not reach full maturity until they are at least 85 per cent of their ultimate size. Such an inference is well substantiated by the developmental forms here presented.

<sup>a</sup> Bidrag til Kundskab om Snyltekrebsene, 1863, p. 149.



as freely movable as any of the other thorax joints. The longitudinal and transverse grooves are also fully formed, so that the dorsal surface presents the same areas as in the adult.

The third and fourth thorax segments have changed but little; the fourth projects farther proportionally over the bases of the fourth legs. There is a similar semiseparation of a fifth segment at the anterior end of the genital segment, and the rudiments of a fifth pair of legs can still be seen at its posterior corners. Neither the segment nor the legs are as prominent as in the preceding stage, and in all probability they soon disappear.

But a radical change has taken place in the genital segment itself. This has widened into a broad acorn shape, as wide anteriorly as posteriorly, with the posterior corners projecting slightly backward and showing the sixth legs plainly at their tips. The abdomen is narrow with straight sides; the anal laminae are very narrow and nearly as long as the abdomen itself, each armed with 4 long plumose setae.

The appendages have now assumed their final form; the second antennae are developed into powerful prehensile organs with long and stout terminal claws. The first and second maxillipeds are about the same size, and neither of them large enough to be of any real service for prehension. The rami of the swimming legs have all become clearly three-jointed, except the endopods of the fourth legs, which in this species remain two-jointed in the adult, and they function as powerful locomotor organs. The transition from this stage to the adult is very slight and consists chiefly in the changes produced in the genital segment by the maturation of the eggs, the consequent enlargement of the oviducts, and the elimination of all traces of a separation into fifth and sixth segments.

The rudimentary fifth legs entirely disappear in the female, and there is absolutely nothing left to indicate that the genital segment contains more than a single thorax joint.

Krøyer<sup>a</sup> notes that the form of the genital segment in all his specimens of females differs from that of the male, and keeps a sexual peculiarity through all its changes, going over gradually from an elongate-angular form into a flask shape.

And he adds: "How far females younger than those I have examined may present on this point an approximation to the males, I may leave to the decision of future investigators."

In the present instance the larval females, which are younger than any he obtained, do not show "an approximation to the male," but even the youngest of them has the distinctive angular form of its own sex.

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<sup>a</sup> Bidrag til Kundskab om Snyltekrebsene, 1863, p. 152.

## ANALYTICAL KEY TO SPECIES.

1. Abdomen distinctly shorter than the genital segment; furca three or four times as long as wide ..... *exilis* Wilson, 1906, p. 678.
1. Abdomen much longer than the genital segment; furca only twice as long as wide ..... 2
2. Carapace wider than long, semilunar; furca with slender elongate branches and small foramen; abdomen of female two-jointed, joints equal.  
*temifurcatus* Rathbun, 1887, p. 679.
2. Carapace longer than wide, elliptical; furca with short, stout branches and very large foramen; abdomen of female three-jointed, joints diminishing in size toward the tip ..... *caudatus* Kröyer, 1838, p. 681

## TREBIUS EXILIS Wilson.

Plate XV, figs. 1 to 7; figs. 2 and 3, pp. 675 and 676.

*Trebius exilis* WILSON, 1906, p. 194, pl. II, figs. 20-33.

*Female*.—Carapace ovate, one-seventh longer than wide, narrowed anteriorly, and well arched. Transverse grooves separating the cephalic and thoracic portions of the lateral areas situated far forward, leaving the thoracic portion much the longer of the two. Eyes small, purplish red, and one-third the distance from the anterior margin. Frontal plates better developed than in either of the following species, but still less than half the width of the carapace. Third thorax segment but a little wider than the fourth and considerably shorter; fourth segment strongly widened between the bases of the fourth legs. Genital segment almost a perfect ellipse, but contracted anteriorly into a narrow neck where it joins the fourth segment. It is more than three-fifths the size of the carapace, and shows neither spines nor legs at the posterior corners in dorsal view.

Egg strings about the same width as the abdomen, but from two and a half to three times its length, thus contrasting sharply with those of *caudatus*. Eggs of medium thickness, 40 to 50 in each string.

Abdomen, even including the anal laminae, at least one-half shorter than the genital segment; made up of a single joint, and of the same diameter throughout. Anal laminae elongate, more than twice as long as wide, each armed with 4 long plumose setae.

Second antennae large and stout; the terminal claw wider at the base than in *caudatus* and relatively as long. But the abrupt bend is at the center instead of near the tip, and this makes the claw appear shorter.

First maxillae straight, small, and weak, the tip not much longer than the enlarged base, and the whole appendage fused to the ventral surface of the carapace. Second pair two-jointed, the basal joint fused to the carapace and carrying at its center near the terminal joint a good-sized rudimentary exopod. The terminal joint (endopod) elongate-triangular and extending for half its length beyond the tip of the mouth tube. This endopod is bluntly pointed without any trace of

bifurcation. Maxillipeds as in the other species. Furca narrow, the length four times the width, the branches short, simple, divergent, pointed, leaving a V-shaped sinus only one-fourth or one-fifth the entire length. Swimming legs all biramose, and the rami three-jointed except those of the first pair and the endopods of the fourth pair, which are two-jointed. Fifth legs small and close to the lateral margins on the ventral surface of the genital segment a little in front of the posterior corners. Cement glands wide and reaching forward almost to the anterior end of the segment; their component cells narrow.

Total length, 5.75 mm. Length of carapace (including third thorax segment), 2.5 mm. Length of genital segment, 1.57 mm.; of the abdomen, 1.1 mm.; of egg strings, 3.1 mm. Width of carapace, 2.1 mm.

*Male*.—Carapace like that of the female but relatively larger, being more than half the entire length. Frontal plates wide and strongly arched anteriorly; eyes small but distinct. Second and third thorax segments relatively wider than in the female; fourth segment the same width as the genital segment, and only a trifle longer than the second and third segments. Genital segment elliptical-oblong, one-fourth longer than wide and not quite one-fifth the entire length. Both the fifth and sixth legs are visible dorsally, the former on the lateral margins at about the center of the segment, the latter at the posterior corners. Abdomen two-jointed, joints equal, but the two together at least one-half shorter than the genital segment as in the female. Anal laminae narrow but nearly as long as the entire abdomen, each tipped with four plumose setae, which in turn are as long as both the abdomen and the laminae. Appendages as in the female, except that the second antennae are sometimes branched as in the males of the *Caliginae*.

Total length, 2.75 mm. Length of carapace (including third thorax segment), 1.4 mm.; of genital segment, 0.5 mm.; of abdomen, 0.6 mm. Color of both sexes (preserved specimens) a uniform yellowish white without pigment.

(*exilis*, slender, graceful.)

Through the courtesy of Prof. W. A. Herdman, of the University of Liverpool, the United States National Museum collection contains a single cotype specimen of each sex of this species (Cat. No. 32723, U.S.N.M.) which were taken from *Rhinoptera javanica* at Ceylon.

#### TREBIUS TENUIFURCATUS Rathbun.

Plate XV, figs. 8-10.

*Trebius tenuifurcatus* RATHBUN, 1887, p. 559, pl. XXIX, figs. 1-3.—BASSETT-SMITH, 1899, p. 462.

*Female*.—Carapace horseshoe-shaped, wider than long, and, including the third thorax segment, about one-third of the entire length.

Frontal plates narrow and not quite half the width of the carapace; lateral lobes reaching back to the posterior margin of the first free thorax segment; no eyes visible.

Transverse grooves separating the lateral areas situated far back, leaving the thoracic portion shorter than the cephalic, as in *caudatus*. These grooves do not make a prominent notch, however, at the edge of the carapace, as in the other two species. But this may well be the fault of the preservation of the specimen, since it has evidently shrunk considerably in the alcohol.

The first free (third) thorax segment is wide and short, while the fourth is longer and narrower and subquadrilateral in outline, showing no increase in width between the bases of the fourth legs. The genital segment is flask-shaped, but its exact proportions and size can not be definitely determined, in consequence of an injury, and also because it is entirely covered with Protozoa. It is certain, however, that it is more than half the size of the carapace, probably fully three-fifths; that the posterior corners are well rounded, and that they do not show any signs of rudimentary legs or spines, as in *caudatus*. In this respect it is similar to *exilis*.

The abdomen is almost linear, nearly twice the length of the genital segment and more than eight times as long as wide.

It is jointed once at the center, the joints being thus of the same length, and the terminal one bearing a pair of short and narrow anal laminae.

The appendages are very similar to those in *caudatus*, the chief difference being that they are more slender and comparatively longer. In the second antennae the basal joints are more slender than in either of the other two species, but the long distal claw is considerably stouter, being fully half as wide as the basal joints. The first maxillae have a swollen circular base and a long terminal portion less than one-fifth the width of the base and bent abruptly at a right angle near the center. The furca is long and slender, with linear rami, which are nearly parallel and more than twice as long as the basal portion. The foramen is small and almost circular.

The swimming legs are of the usual pattern, both rami of the fourth pair being three-jointed.

Total length 6.5 mm. Length of carapace, including the third thorax segment, 2 mm.; of the fourth segment, 0.5 mm.; of the genital segment, 1.5 mm.; of the abdomen, 2.5 mm. Width of carapace, 2.4 mm.

Color of the preserved specimen a darker yellow than in *caudatus*, without any pigment.

(*tenifurcatus*, *tenuis*, slender, and *furcatus*, furnished with a furca.)

This species was founded by Rathbun in 1887 upon a single poorly preserved specimen. As a usual thing under such circumstances it is

better to wait for further material before establishing a new species. But after a personal examination of the present specimen its identity as a new species is so apparent that the author considers Rathbun fully justified in making of it a new species without waiting for more specimens.

It is Cat. No. 6193, U.S.N.M., and was taken from a sting ray captured in Vineyard Sound, Massachusetts, by the United States Fish Commission in 1871.

**TREBIUS CAUDATUS** Kröyer.

Plate XV, figs. 11-13; Plate XVI, figs. 14-22; fig. 1, p. 673.

*Trebius caudatus* KRÖYER, 1838, p. 30, pl. I, fig. 4.—M. EDWARDS, 1840, p. 458.—BAIRD, 1850, p. 280, pl. XXXIII, figs. 3 and 4.—KRÖYER, 1863, p. 149, pl. X, fig. 1 *a-k*.—OLSSON, 1869, p. 14, pl. I, figs. 3 and 4.—THOMPSON, 1888, p. 69, pl. II, fig. 10.—T. SCOTT, 1900, p. 155, pl. VI, figs. 20-26.

*Female*.—Carapace orbicular, a little longer than wide, somewhat contracted anteriorly and well arched dorsally. Frontal plates narrow and only two-fifths the width of the carapace. Transverse grooves separating the cephalic and thoracic portions of the lateral areas far back, leaving the thoracic portion much the shorter of the two. Eyes not showing in the adult but visible in the young as two purplish-red spots, not fused but close together and about one-third the distance behind the anterior margin. Third thorax segment one-half wider than the fourth, but not as long; fourth segment spindle-shaped, being widened considerably between the bases of the fourth legs.

Genital segment enlarged to about three-fifths the size of the carapace, flask-shaped, the anterior end narrowed into a short neck where it joins the fourth segment. The posterior corners are evenly rounded and armed on the dorsal surface with three or four stout, broadly triangular spines which project over the bases of the egg-strings. The latter are usually a little longer and about the same width as the abdomen. Sometimes, as in one of Kröyer's two original type specimens, the egg strings are not as long as the abdomen. Eggs quite small, from 30 to 40 in each string.

Abdomen one-half longer than the genital segment and only three-eighths as wide; three-jointed, the joints diminishing greatly in length and slightly in width from the base toward the tip.

Anal laminae short and narrow, each armed with four small plumose setae, of which the outer and inner ones are the shortest.

Second antennae with the two basal joints thick and stout, the terminal claw long, slender, and not more than one-fifth as wide as the basal joints. First maxillae long for a female, thick and stout, with the base swollen into a transversely elliptical form. Second maxillae elongate-triangular, with the basal joint fused to the ventral surface

of the carapace and armed with a rudimentary exopod, as in *erilis*. The endopod in the present species, however, is bifurcate at the tip; the inner branch slender and pointed, the outer one twice the length of the inner, stout, and bluntly rounded at the end.

Furca small, the length only twice the width; the rami simple, short, stout, bluntly rounded, and less than half the length of the basal portion. The latter is elliptical or oval with a large foramen of the same shape.

The swimming legs are all biramose, the rami of the first pair two-jointed, of the other pairs three-jointed. Fifth legs invisible dorsally, but consisting of a small papilla at each posterior corner of the genital segment on the ventral surface.

Oviducts not much coiled in the genital segment; cement glands of the usual shape, parallel with each other, and reaching well forward toward the anterior margin of the segment; the gland cells short and transversely linear.

Total length, 9 mm. Length of carapace, including third thorax segment, 3 mm.; of genital segment, 2.33 mm.; of abdomen, 3 mm.; of egg-strings, 2.8 to 4 mm. Width of carapace, 2.5 mm.

Alcoholic specimens a dull yellowish horn color without any traces of pigment.

(*caudatus*, tailed, alluding to the great length of the abdomen.)

*Male*.—Carapace orbicular half the entire length, and fully as wide as long; only slightly narrowed anteriorly. It is even more strongly arched than in the female and, as Kröyer says, may be called “hunch-backed,” since the posterior portion falls away rapidly. The markings and grooves are similar to those on the female. The third thorax segment projects behind the lateral carapace lobes considerably farther than in the female; it is twice the width of the fourth segment, but about the same length. The fourth segment is spindle-shaped and about the same width as the genital segment.

The latter is proportionally very small, less than one-fifth the entire length, a little longer than wide, with the sides and posterior end evenly rounded, while the anterior margin is squarely truncated. Abdomen narrow and a little longer than the genital segment, made up of two joints about the same width, but the terminal one one-third longer than the basal.

Anal laminae one-quarter the length of the abdomen, slightly divergent, and each armed with five plumose setae, the inner of which is the longest and about three times the length of the lamina. Appendages as in the female. In speaking of the second maxillipeds, Kröyer says that he is “certain they are three-jointed since the base of the claw where the seta goes out shows a distinct jointing.” This does not seem probable, and none of the specimens examined by the author show it.

The three terminal claws on the end of the exopod of the first swimming legs are toothed, the first one along the posterior margin, the other two along both margins.

The genital segment shows two pairs of rudimentary legs on its ventral surface, the first pair two-thirds of the length from the anterior end and close to the lateral margins, the second pair at the posterior corners.

The semen receptacles are sausage-shaped, the posterior portion enlarged into a more or less spherical sac, the anterior part made up of the coiled duct.

Total length, 4.5 mm. Length of carapace, 2.3 mm.; of genital segment, 0.8 mm.; of abdomen, 1.10 mm. Width of carapace, 2.8 mm.; of genital segment, 0.6 mm.

Color as in female. The United States National Museum collection includes a single lot of this species, numbering eight specimens, which were taken from a skate off the coast of Shetland (Cat. No. 8033, U.S.N.M.), and are all finely preserved.

This is Kröyer's original type species of the genus; he described the female in 1838 and the male in 1863.

It is a very common species and has been described by many zoologists since Kröyer's day, each in his turn adding something to the details already known. The present account has collected all these details and supplemented them where lacking, and also supplies several new figures, bringing the account of the species up to date. Certain of the figures have been placed on Plate XV in order to facilitate a comparison between the three species and thus bring out more clearly the specific differences. The three species have been under the author's observation simultaneously, and there can be no doubt of their validity.

#### Subfamily EURYPHORINÆ.

Sexes similar as in the Caliginæ. Carapace broad and compressed, made up of the three anterior thorax segments fused with the head. The fusion, however, is not always as complete as in the Caliginæ, but shows a marked transition in the different genera. In *Alebion* and *Gloiopotes* the three first segments are fully blended with no grooves between them. In *Euryphorus* and *Dysgamus* the second and third segments are fused *inter se*, but are well separated from the first, while in the new genus *Dissonus* all three thorax segments are free and as completely separated as in the Pandarinæ.

Frontal plates well defined, but never furnished with lunules. The fourth thoracic segment small, free, and furnished in the females with a pair of dorsal plates which usually overlap the following (genital) segment. This latter is large and nearly always lobed posteriorly; it is covered in *Euryphorus* with a large membranous wing made up of

a pair of fused dorsal plates, but is without any covering in the other genera.

Abdomen two-jointed, elongated; the first joint much enlarged in *Euryphorus* and furnished with a pair of lateral wings; in the other genera without wings or plates.

Second maxillæ showing a marked transition from a simple, pointed form in *Caligeria* and *Elytrophora* through a blunted, biramose shape in *Gloiopotes* into a flattened lamina in *Alebia*, very similar to that found in the Pandarinae.

All four pairs of thoracic legs usually biramose and armed with plumose setæ, the first pair in *Caligeria* and the first and fourth pairs in *Gloiopotes* uniramose. The remaining appendages and anal laminae as in the Caliginæ. In development the young are never attached by a frontal filament, but by the enlarged second antennæ.

#### ONTOGENY.

The life history of the genera belonging to this subfamily is very similar to that in the Caliginæ, but differs in several important details, which differentiate the two subfamilies clearly.

The flattening of the eggs in the egg-strings, the symmetrical arrangement of all the embryos in the same string, and the change of color due to the increase of pigment with advancing development are the same as already described. About ten weeks are required for development in such species as have been observed, and all the eggs in a given string hatch at practically the same time. The issuing nauplius is similar to those of the Caliginæ and differs from them chiefly in one particular.

It is elongate in form, the two ends being about the same size and evenly rounded; there is the same eye-spot and supracesophageal ganglion; the three pairs of appendages, the first antennæ uniramose and terminating in two long plumose setæ, the second antennæ and mandibles biramose, the exopod four-jointed, each joint bearing a long plumose seta, the endopod one-jointed and terminating in a single seta.

The anterior part of the body is transparent and shows the muscles which move the appendages, while the posterior part is filled with yolk granules which render it opaque.

But when we examine the balancers near the posterior end of the body we find them quite different from those which characterize the Caliginæ. Instead of a cylindrical base and a broad spatulate tip we have here a longer and more slender appendage tapering directly from base to tip like a very long and acuminate spine. Usually also they stand out at right angles to the central axis and are slightly curved forward.



We find here the same variation in the color and pattern of the pigment spots as in the previous subfamily, and they furnish equally good means of identification.

It is even more difficult to hatch these nauplii and rear them through successive moults than it was in the case of the *Caliginæ*. This is due to several causes.

Both sexes of the adults in the genus *Alcbion* are very active when kept in aquaria, swimming about restlessly all the time. And they have the same pernicious habit as *Caligus* of crawling up out of the water as far as they can get and remaining there until dead and dried. Again with *Caligus*, if the female's egg-strings were nearly or fully ripe, she usually refrained from this suicide until after the nauplii had emerged. But the ripeness of the eggs seems to make no difference with *Alcbion*, and as a consequence it is very seldom that a brood of nauplii can be obtained in captivity. The explanation of this conduct may possibly be found in the fact that the genera belonging to this subfamily are extremely sensitive to temperature changes in the water. A rise of only a few degrees is quickly fatal, and it usually happens that nearly all the specimens obtained during the hauling of a fish net are dead before reaching the laboratory, even though they were placed in fresh water and in an absolutely clean receptacle. About the only way they can be kept alive is to change the water so frequently that there can be practically no rise in the temperature. But even then they do not live as long as *Caligus* or *Lepeophtheirus*, and make very poor aquarium material. This is especially true of the adult females; the males and young females are rather more hardy.

From this it would naturally be inferred that the life-history is a difficult matter to obtain, but there is still a chance of success because, as soon as the nauplius moults into the metanauplius, it fastens itself at once to its host and there remains until fully developed. Hence a careful search of the host at the proper time is almost sure to yield development stages of the parasite. Fortunately the hosts for the two species of *Alcbion* here presented are the smooth dogfish and the sand shark, two of the most common fish along the Atlantic coast. The eggs hatch during the latter part of June and the first of July so that the best time to look for the development stages is during the first two weeks in the latter month. They may be found anywhere upon the shark's body, but seem to prefer the mid-line of the dorsal surface just in front of the dorsal fins. Frequently they are huddled together in clusters and are so close to one another that there is not room for them all to rest against the skin of the host, and some are obliged to stand out from the surface at a greater or less angle. In such instances they resemble a chalcid very closely since the only part of their body in actual contact with the host is the pair of long second antennæ, and they float out in the water much as though fastened by a short frontal

filament. In this condition they could easily be mistaken for chalimi, and no doubt have been before now.

From one small shark on July 4, 1904, a strip of skin an inch long and half an inch wide, taken from just in front of the posterior dorsal fin, contained thirty-five of these embryos.

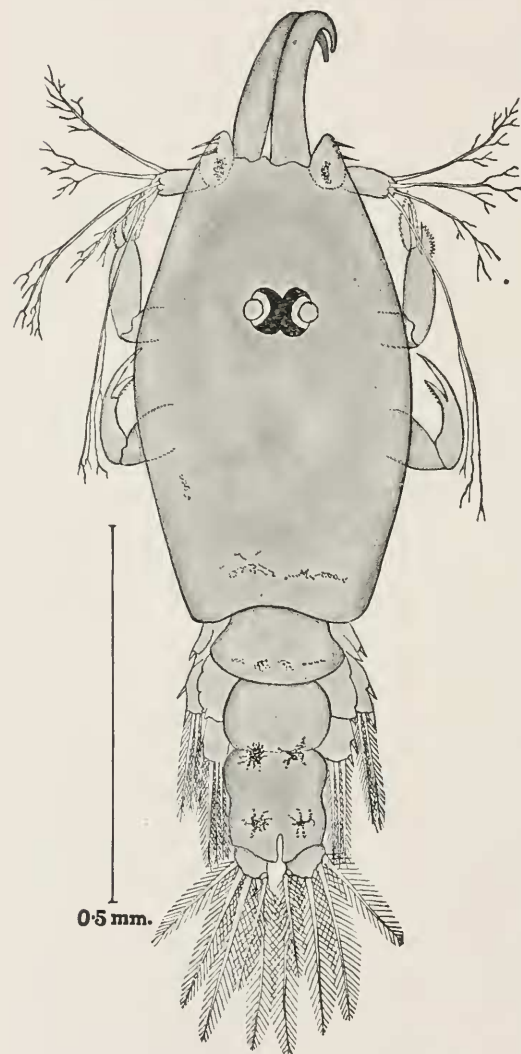


FIG. 4.—THE METANAUPLIUS OF ALEBION GLABER.

thoracic segment. This fusion is more complete than it was in the metanauplius of the Caliginæ, and constitutes a noticeable difference between the two subfamilies.

In this particular, then, the *Alebion* metanauplius is as far advanced as the chalimus of the Caliginæ, and exhibits the first step toward

On removing them from the shark's body and examining them under magnification they are found to resemble a chalimus quite closely in their structure and in the number and arrangement of their appendages. The essential points in which they differ are the entire lack of a frontal filament, which materially alters the form of the frontal plates and the structure of the second antennæ. In this bunch of thirty-five were found all stages of development, from a metanauplius just attached up to larvæ ready to molt into the adult form.

The metanauplius (fig. 4) is quite similar to that of *Caligus* and *Lepeophtheirus*, so nearly like them as to be readily recognized and yet so different that there can never be any danger of confusion. The carapace is spindle-shaped, narrowed both anteriorly and posteriorly, and consists of the head fused with the first

that precocious development which characterizes the more degenerate families of these parasites.

This is important in its bearing upon degeneration, since it is the very first evidence to be obtained from the development stages. And its value is enhanced from the fact that it occurs in a species whose adult form shows no appreciable diminution of bodily functions or morphology. The adults of both sexes in this genus swim as freely and as actively as any *Caligus*. Their fourth swimming legs, to be sure, have been reduced to mere stumps, and the fourth segment, which carries them, is covered by a pair of small dorsal plates. But, even in this condition, they are about as serviceable as the corresponding members in *Caligus*; that is, they are of no real service in either case so far as can be determined.

The eyes are situated well back toward the center of the carapace and are relatively very large. The pigment is not as extensive as in the Caliginæ, the lens being surrounded by a large, clear area. Over the dorsal surface also, in place of the broad lateral pigment lines and the large area in front of the eyes, we find only isolated pigment spots and very few of them. There is a single small spot in the frontal plate on either side at the base of the first antenna and a narrow line across the posterior end of the carapace near the margin.

There is a similar narrow line across the posterior margin of the first free segment, a pair of large spots in the groove between the second free segment and the abdomen, and another pair of spots at the posterior end of the abdomen over the bases of the anal laminae. This metanauplius, therefore, has very little pigment, while the same stage of development in the Caliginæ was highly pigmented.

The carapace is followed by two free thorax segments and the abdomen; only the first of the free segments bears swimming legs. The abdomen at this stage is really a fusion of the fourth thoracic, the genital and abdominal segments, the two former being not as yet differentiated. It is as wide as the last thorax segment and terminates in two rather short anal laminae, each armed with five plumose setae.

The first antennae are two-jointed, the terminal joint bearing remarkably long and branched setae, which are not feathered as in the Caliginæ. These setae are remarkable in several particulars among those of all the parasitic copepods thus far examined. They are longer than even the plumose rowing setae on the second antennae and mandibular palps of the *Argulus* larva. They extend outward in every direction like ordinary antennal setae, but instead of being plumose they are dichotomously branched toward the tips and thus terminate in a flattened web or mat very similar to that formed by certain algae. Evidently they have retained much of their old locomotor function which they possessed in the nauplius stage.

In all the specimens obtained the basal joint of these first antennæ was folded over beneath the ventral surface, as shown in the figure. That this is the normal attitude and not a folding due to pressure was proved by examining some in an open-watch glass, and by the fact that many of the larvæ in the subsequent chalinus stage showed the same folding.

The second antennæ, unlike the first, have entirely lost their locomotor function and have become prehensile (fig. 11). Each now consists of a long and stout basal joint, extending straight forward beyond the anterior margin of the frontal plate, and an elongated slender terminal claw, which is bent over ventrally into a half circle. These second antennæ extend in front

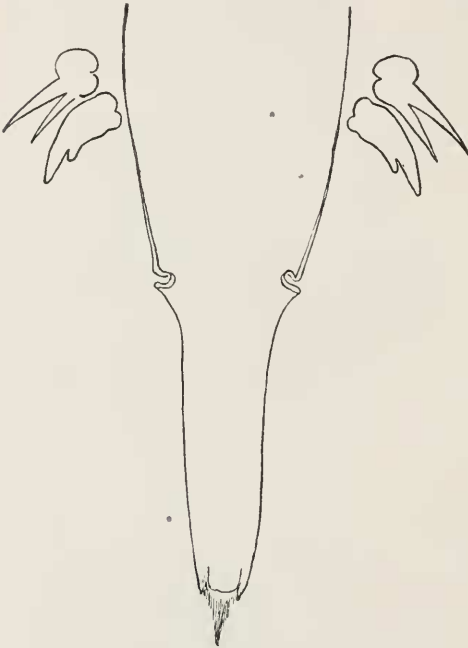


FIG. 5.—MOUTH AND SECOND MAXILLE OF THE METANAUPLIUS OF ALEBION GLABER.



FIG. 6.—FIRST MAXILLIPED OF THE METANAUPLIUS OF ALEBION GLABER.

of the carapace a distance equal to about half the length of the latter. And when driven into the skin, the claws afford a powerful hold and effectually protect the larva against removal by friction or similar cause.

The mouth (fig. 5) has developed into a long proboscis hinged near the center, inside of which, at the very tip, can be seen the mandibles. The mouth opening is terminal, somewhat elongated, and surrounded by a fringe of long hairs. On either side of the mouth tube at its base are the second maxillæ, which at this stage consist of two entirely separate rami of about the same size. Of these the endopod is short and stout and slightly bifurcate at the tip, the outer branch being considerably longer and larger than the inner. The exopod is made up of two diverging slender spines joined together at the base. In this

metanauplius stage, therefore, the two rami of the second maxillae are equally developed, and there is no indication of the subsequent difference between them. But we shall find a marked change in the chalinus stage.

The first maxillipeds (fig. 6) are two-jointed with the joints about the same length. The basal joint, however, is stout, while the terminal one is slender and ends in two spines, the inner of which is twice the length of the outer.

The inner spine is also slender and has a toothed membrane along both its inner and outer margins; the outer spine is triangular, strongly flattened, and toothed along the outer margin only.

The second maxillipeds (fig. 7) have a very stout basal joint, while the terminal claw is slender, apparently three-jointed, and has an auxiliary spine on the inner margin of the second joint, this spine being toothed.



FIG. 7.—SECOND MAXILLIPED OF THE METANAUPLIUS OF ALEBION GLABER.

The swimming legs each consist of a large disk-like basal joint and two one-jointed rami bearing long plumose setae.

There is a long slender spine at the outer distal corner of the basal joints in each pair. The exopods of the first pair carry three short and stout spines along their outer margins, while the exopods of the second pair carry only two (fig. 8). The endopods of this latter pair, however, carry a smaller spine on their outer margin, while the endopods of the first pair have no spines.

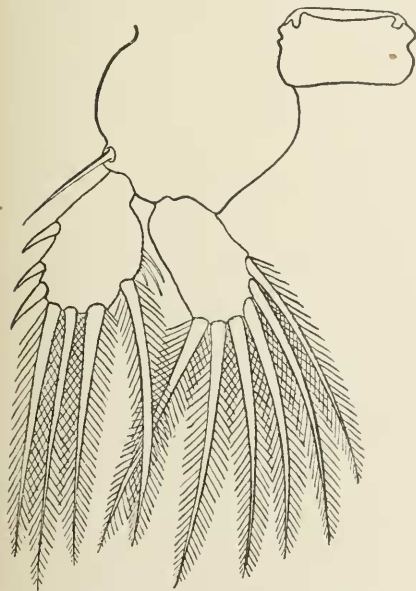


FIG. 8.—THE FIRST SWIMMING LEG OF THE METANAUPLIUS OF ALEBION GLABER.

Each of these two pairs of legs is connected across the mid line by a basilar chitin plate. The one connecting the first pair is transversely oblong with a small posterior margin, while that connecting the second pair is horseshoe-shaped and of about the same width and length (fig. 9). The horseshoe opens toward the posterior end of the body and its

sides are proportionally very wide. The abdomen has a slight constriction on either side near the center, which indicates a division during the next moult, the fourth thorax segment separating and becoming free. There is a deep anal sinus at the posterior end of the abdomen, on either side of which are the anal laminae. These are rather small and each carries five long and stout plumose setae.

This larva is colorless except for the pigment spots already described, but is disappointingly opaque. Total length (including second antennae), 1.1 mm. Width of the carapace, 0.4 mm.

At the next molt these metanauplii change into a stage corresponding to the early chalinus of the Caliginæ.

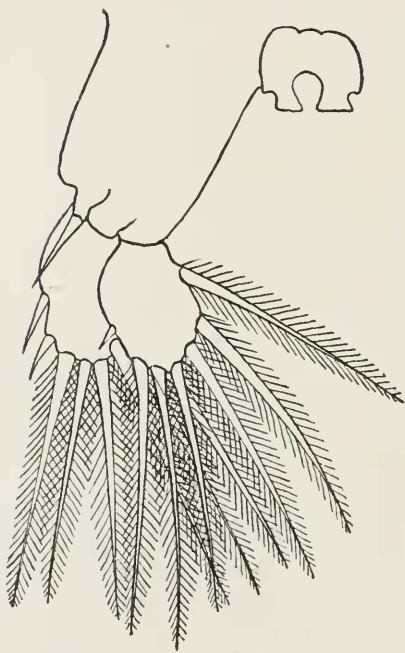


FIG. 9.—THE SECOND SWIMMING LEG OF THE METANAUPLIUS OF ALEBION GLABER.

Although they differ in many important particulars from the form which was taken as the type of the so-called *Chalinus*, and although they even lack a frontal filament which was the essential character of the chalinus, yet it is considered best to retain that name for this stage of development in order to avoid a multiplicity of terms. Accordingly we designate this stage in the Euryphorinæ as the chalinus stage.

The carapace (fig. 10) is oblong, covering more than half the entire body. It is widest at the center and narrowed toward either end, the posterior margin being about the same width as the frontal plates. The latter are thoroughly fused with each other and with the carapace; their anterior margins meet in a rounded projection at the center instead of an incision, while the lateral margins project on either side far over the basal joints of the first antennae.

The posterior margin of the carapace is nearly straight through the center, with a short and narrow lobe at either corner which lies closely appressed to the lateral margin of the first free segment. The eyes are situated in about the same relative position as during the metanauplius stage and are fully as large, with prominent spherical lenses. The pigment in them is dark red in color and more abundant than in the previous stage. The pigment also on the dorsal surface has increased considerably in volume, and is found in the shape of spots and lines scattered freely along the sides of the carapace, the free segments, and

the abdomen. This is similar to the condition found in the chalimus of the Caliginæ.

The first thorax segment is still imperceptibly fused with the carapace, but the second and third segments are clearly separated from it, though they have become partially fused *inter se*.

The second segment has become nearly as wide as the carapace and its lateral margins extend out over the bases of the second legs in the form of broad lobes. The third segment is also widened and now bears a pair of swimming legs similar to the first two pairs. The fourth and genital segments still remain fused with the abdomen, but have elongated considerably, while the constriction which indicates the future separation of the fourth segment is more clearly marked.

The anal laminae are longer than in the meta-nauplius and closer together, but the plumose setæ with which they are armed are greatly reduced in size, and there are only three of them on each lamina, all terminal. The other plumose setæ of the meta-nauplius are here represented by two small spines on the outer margin of each lamina.

On comparing this chalimus with that of the Caliginæ we again find evidence of precocious development, this time in the separation of the fourth segment. The second and third segments are fused *inter se* in both subfamilies; in the Caliginæ there is no indication of the separation of

the fourth segment, while here that separation is clearly indicated by a well-marked constriction. This would mean very little by itself, but at the next molt, when the fourth segment is fully separated in both subfamilies, we find it without appendages in the Caliginæ but with a pair in the Euryphorinæ.

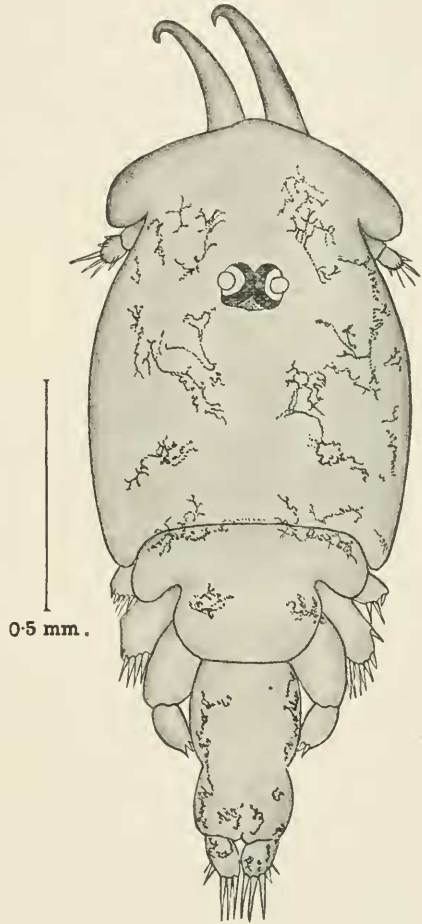


FIG. 10.—THE (FEMALE) CHALIMUS OF ALEBION GLABER.

In the latter case these appendages are very rudimentary, to be sure, but they are all the copepod ever possesses and are as fully developed as in the adult.

Of the other appendages in this *Alcbion* chalmus the first antennae are normal and two-jointed, but the basal joint is nearly concealed in a dorsal view by the projecting margins of the frontal plates. Both joints are plentifully supplied with normal setae, the long and dichotomously branched forms of the metanauplius having entirely disappeared.

The second antennae (fig. 11) are like those of the previous stage and continue to serve as organs of attachment by which the larva is fastened to its host. This constitutes the most important difference in the development of the two subfamilies.

In all the genera belonging to the Caliginæ whose larvæ have thus far been obtained, the chalmus and subsequent stages up to the adult form are characterized by the presence of a frontal filament, by means of which the larva is securely fastened.

The remains of this filament may be seen in the young adults of both sexes and of all the genera, and is satisfactory proof of its presence during development even in those forms whose larvæ have never been actually seen.

In the genus *Alcbion*, on the contrary, there is no frontal filament at any period of development, the second antennae serving as the only organs of attachment up to the adult stage.

The life history of *Alcbion* is the only one at present fully known in the subfamily Euryphorinæ, but we have the same evidence here in a negative way that we had positively in the Caliginæ. None of the adults in any of the genera thus far examined show traces of a frontal filament; the younger adults certainly ought to do so, provided such a filament exists during their development.

The first maxillæ are minute and easily overlooked; they are quite close to the margin of the carapace, and have the shape of a comma, the base nearly spherical while the tip is short and blunt.



FIG. 11.—THE SECOND ANTENNA AND FIRST MAXILLA OF THE CHALMUS OF *ALCBION GLABER*.



The second maxillae are simple and made up of a stout cylindrical base, abruptly rounded and tipped with a short triangular spine (fig. 12). This represents the endopod of these maxillae as seen in the metanauplius stage; the exopod has even thus early degenerated into the form seen in the adult, a papilla fused with the base of the endopod and carrying two small spines.

The mouth tube is cylindrical and nearly as wide at the tip as at the base; the mouth opening is subterminal (a little ventral), and heavily fringed with hairs. When viewed from the ventral surface the tips of the mandibles can be seen inside the opening. They are slender and two-jointed, the terminal joint only one-eighth as long as the

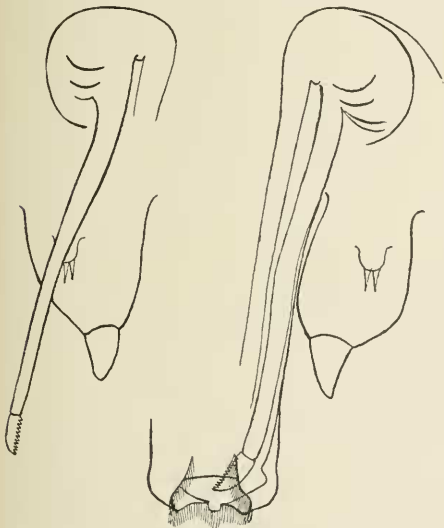


FIG. 12.—THE MOUTH-TUBE, MANDIBLES, AND SECOND MAXILLAE OF A MALE CHALMUS OF ALEBION GLABER.

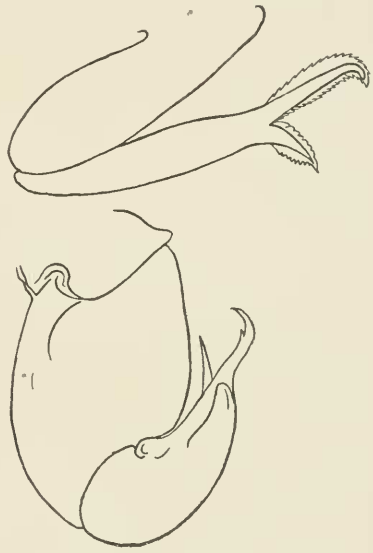


FIG. 13.—THE FIRST AND SECOND MAXILLIPEDS OF A CHALMUS OF ALEBION GLABER.

basal and minutely toothed along its inner margin, the number of teeth being eighteen or twenty.

The first maxillipeds (fig. 13) are similar to those in the adult, the two joints about the same length, but the basal joint considerably the stouter. Both the terminal claws have a toothed membrane along their inner and outer margins.

The second maxillipeds are short and stout; the basal joint is nearly as wide as long, and is filled with strong muscles; the terminal claw is stout at the base but tapers to a weak tip, not much longer than the accessory spine and only slightly curved.

All three pairs of swimming legs (fig. 14) are biramose and the rami are one-jointed. In the first pair the exopod is as long as the basal

joint and much larger than the endopod; both rami terminate in stout spines, three on the exopod and two on the endopod, with several smaller accessory ones on the outer margins. In the second legs the two rami are about the same length, broad and disk-like, and much shorter than the oblong basal joint. They also terminate in stout spines, five on each ramus.

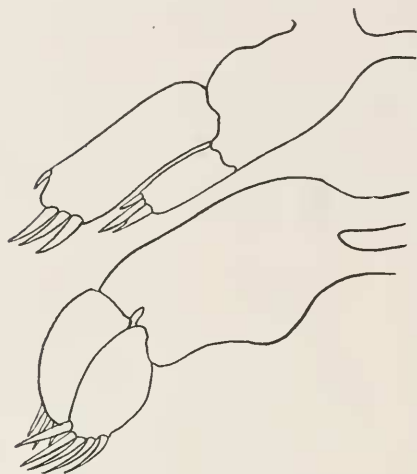


FIG. 14.—THE FIRST AND SECOND SWIMMING LEGS OF A CHALIMUS OF ALEBION GLABER.

The young male is very similar to the female, except that the carapace is relatively larger, while the free segments of the thorax are much shorter and the segmentation is more distinct.

The fourth legs (fig. 16) appear toward the close of this chalimus stage, and are distinctly bifurcate at the ends, the two rami being very minute. At the next molt the segment carrying them is fully separated from those which follow it. The posterior portion of the body now rapidly elongates, and the larva advances by several (4 or 5) molts toward its adult form. The genital segment is separated from the abdomen; at first smaller than the latter, as in the Caliginæ, it increases until it becomes much larger. The swimming legs also increase in size, and the large apron of the third pair becomes fully developed across the posterior end of the carapace, completing with the latter the large sucking disk which is to constitute the chief organ of attachment to the body of the host. At the same time the second antennæ, which have remained as organs of attachment through these early stages,

In the third legs (fig. 15) the rami are almost exactly like those on the second legs, but the basal joint is very much swollen and has obtained a good start toward the broad lamellar condition of the adult. The exopod terminates in five spines, considerably smaller than those on the second legs, while the endopod has only three. There is no trace of the fourth or fifth legs at this stage of development.



FIG. 15.—THE THIRD SWIMMING LEG OF A CHALIMUS OF ALEBION GLABER.

now decrease in size, become of secondary importance, and finally assume their adult form (fig. 17).

These facts with regard to development settle several questions which have hitherto been in dispute.

In the first place they fully justify the separation of the genus and its near relatives from the Caliginæ on the one hand and from the Pandarinæ on the other, and their establishment as a new subfamily intermediate between these two.

In the genus *Alebion* the fourth legs are so rudimentary that it is impossible to tell from the morphology of the adult whether they are to be regarded as uniramous or biramous.

Consequently it has been difficult to locate the genus with any certainty; Heller placed it among the Caliginæ, with which it is closely affiliated in morphology and habits; Gerstaecker placed it in a subfamily which he called the Nogagina as intermediate between the Caliginæ and the Pandarinæ. This latter is the correct position, as the development proves. The mouth-parts and maxillæ are like those of *Caligus* in early development, but there is no frontal filament, the second antennæ serving in its place. As development progresses the maxillæ become broadened and flattened into laminae (fig. 18) very similar to those of *Pandarus*, while the second antennæ are reduced to normal size and shape. But the female never degenerates into a fixed form like *Pandarus*; on the contrary, the adults of both sexes are fully

FIG. 16.—A CHALIMUS OF ALEBION GLABER JUST READY TO MOLT INTO THE ADULT STAGE, SHOWING THE FOURTH SEGMENT SEPARATED AND THE FOURTH LEGS ALREADY FORMED.

as lively as any *Caligus* and both swim and scuttle about freely. They thus show characters belonging to both the subfamilies mentioned and constitute a well-defined connecting link between them. This is exactly where Gerstaecker has placed them, but there are several reasons why his name of Nogagina can not be accepted for the subfamily.

The first objection is to the name itself. The genus *Nogagus* is made up entirely of males belonging to other genera, *Pandarus*, *Nesipus*, *Demoleus*, *Echthrogaleus*, and *Dinematura*. It has, therefore, no right whatsoever to appear as a separate genus, much less to be taken as the type of a subfamily.

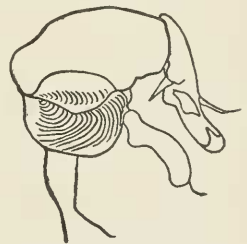
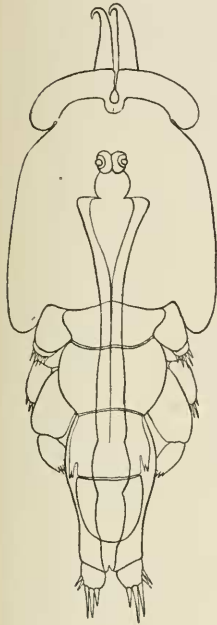


FIG. 17.—THE SECOND ANTENNA OF AN ADULT MALE OF ALEBION GLABER.

There are more species of "*Nogagus*" which are the males of *Pandarus* than of any of the other genera mentioned; hence we should have the anomaly of two subfamilies—one founded on the females and the other on the males—of the same genus.

A second objection is found in the fact that both Gerstaecker and Steenstrup and Lütken are obliged to separate their *Nogagus* males into two groups on generic characters. If this means anything at all it means that we have here two distinct genera under the same name, and this confusion at least ought to be cleared up before the name is used for the type of a subfamily.

Finally, in the subfamily Nogagina, as constituted by Gerstaecker, we find a heterogeneous medley of forms which manifestly do not belong together. As already stated, many *Nogagus* species are the males of *Pandarus*, while others belong to the genera *Nesippus*, *Demoleus*, *Echthrogaleus*, and *Dinematura*. This very resemblance of

the males would suggest strongly that these five genera belong to the same subfamily. Further investigation proves the truth of this suggestion, and they must be classed with the Pandarinae, as will be clearly shown under that family.

But when you have removed these five genera from Gerstaecker's Nogagina there is not a single species of *Nogagus* left, and hence that name must be dropped. Furthermore, of the genus *Dysgamus*, which Gerstaecker includes in this same subfamily, only the males have been thus far examined.

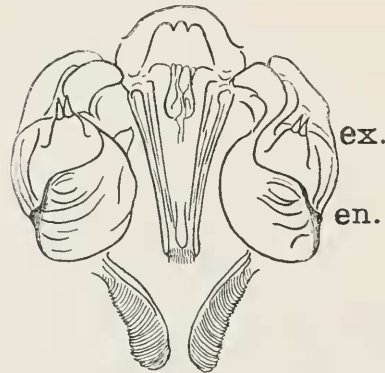


FIG. 18.—THE MOUTH-TUBE AND SECOND MAXILLA OF AN ADULT MALE OF ALEBION GLABER.

We can not be sure, therefore, whether this is even a valid genus, and of course can not locate it with certainty (see p. 712). The genus *Trebius*, also included by Gerstaecker in the Nogagina, is classed by most authors with the Caliginae. We have chosen to place it by itself for reasons stated on p. 670, but wherever it may be placed it clearly does not belong with "*Nogagus*." These eliminations reduce the ten genera which Gerstaecker included in his Nogagina to three, and *Nogagus* is not one of the three.

With these three are to be included Steenstrup and Lütken's *Gloiopotes* and Dana's *Caligeria*, Steenstrup and Lütken's *Dysgamus* (provisionally), and the new genus *Dissonus*, making seven genera in the subfamily. Steenstrup and Lütken<sup>a</sup> have already separated this group very clearly from the rest of the Caliginae but did not constitute

<sup>a</sup> Bidrag til Kundskab om det aabne Havs Snyltekrebs og Lerneer, 1861, p. 11.

for it a distinct subfamily. That we are now justified in doing, and accordingly the name of the oldest of the five genera, *Euryphorus* (Milne-Edwards, 1840), has been selected for the name of the subfamily, which becomes the Euryphorinæ.

#### SUMMARY.

1. The life history of the genera belonging to this subfamily is similar to that of the Caliginæ except in the following details.

2. The balancers near the posterior end of the nauplius's body are more slender, are cylindrical throughout, and stand out at right angles to the central axis.

3. In the metanauplius the first thorax segment is completely fused with the carapace, a condition as far advanced as that of the chalimus in the Caliginæ. It thus exhibits the first step toward that precocious development which characterizes the more degenerate families of these parasites.

4. The setæ on the terminal joint of the first antennæ in the metanauplius are not plumose, but are very long and dichotomously branched toward their tips, forming a web or mat like that in certain algæ. They thus retain much of the locomotor function which they possessed in the nauplius stage.

5. The second maxillæ in the metanauplius consist of two entirely separate rami of about the same size. The endopod is short and stout and slightly bifurcate at the tip; the exopod consists of two slender diverging spines united at the base.

6. In the chalimus stage there is no frontal filament; instead, the second antennæ are enlarged and extend straight forward in front of the carapace, serving as the only organs of attachment.

7. In the chalimus stage also the second and third segments are fused *inter se*, while the separation of the fourth segment is clearly indicated by a well-marked constriction. This is another evidence of precocious development, for in the following molt, when the fourth segment is fully separated in both subfamilies, we find it without appendages in the Caliginæ, but with a pair in the Euryphorinæ.

8. The second maxillæ in the chalimus are simple, the exopod having thus early degenerated into the form seen in the adult, a papilla fused with the base of the endopod and carrying two small spines.

9. The fourth legs when they first appear are distinctly bifurcate at the tips, the two rami being minute.

10. This life history clearly separates the genera here included from the Caliginæ on the one hand, and, reenforced by the morphology of the adults, from the Pandarinæ on the other. We are thus justified in constituting for them a separate subfamily, intermediate between the two, which is named for the oldest genus included in it, the Euryphorinæ.

## ANALYTICAL KEY TO GENERA.

1. Three thorax segments fused with the head; the fourth segment only free..... 2
1. Only the first thorax segment fused with the head, the others free; no dorsal plates; all the swimming legs biramose, the rami three-jointed.
  2. One or more pairs of legs uniramose, the others biramose ..... 3
  2. All four pairs of swimming legs biramose..... 4
3. First legs only uniramose, their terminal claws curved and simple; setæ on anal laminae short and non-plumose..... *Caligera* Dana, 1852.
3. First and fourth legs uniramose; claws on first pair straight and three-parted; setæ on anal laminae long and plumose.
  4. Exopod of fourth legs three-jointed, endopod two-jointed ..... 5
  4. Both rami of fourth legs with the same number of joints..... 6
5. Setæ on fourth legs plumose; first abdomen joint much larger than second and covered with a dorsal wing or with two lateral wings.... *Euryphorus* M.-Edwards, 1840.
5. Setæ on fourth legs non-plumose; abdomen joints about the same size, without wings..... *Elytrophora* Gerstaecker, 1853.
6. Rami of fourth legs small, the two joints fused; rami of first three pairs two-jointed, without horny processes ..... *Dysgamus* Steenstrup and Lütken, 1861, p. 712.
6. Fourth legs rudimentary, hidden; exopods of first three pairs with horny processes..... *Aleblion* Krøyer, 1863, p. 702.

## Genus GLOIOPOTES Steenstrup and Lütken.

Carapace large, oval, shield-shaped. Frontal plates wide and distinct, without lunules; first antennæ slender and two-jointed, like those of *Caligus*. Mouth tube short and wide; second maxillæ bifurcate and flattened, but not laminate, as in *Pandarus*. Furca compound. Fourth thorax segment free, with two dorsal plates which cover a portion of the genital segment. First and fourth thoracic legs uniramose, second and third biramose; terminal claws on the first legs three-parted.

Genital segment large, produced backward in the female on either side of the abdomen in the form of an elongated, curved process, carrying a serrated, styli-form appendage on its outer border. Genital segment in the male without posterior processes, but having the styli-form appendages attached directly to its sides. Abdomen slender and two-jointed; anal laminae elongate and filiform. Egg-cases and eggs as in *Caligus*.

(*γλοιός*, knavish, and *πότιης*, a drinker or tippler.)

## ANALYTICAL KEY TO THE SPECIES.

1. Dorsal plates on the fourth segment short and rounded, covering only a little of the genital segment ..... 2
1. Dorsal plates elongate, rectangular, covering all the genital segment except the processes..... *hygomianus* Steenstrup and Lütken, 1861.
  2. Dorsal plates semilunate, longer than wide; first antennæ concealed; abdomen smooth ..... *huttoni* (Thomson, 1889).
  2. Dorsal plates much wider than long; first antennæ prominent; abdomen heavily armed with spines along the sides..... *ornatus* Wilson, 1905, p. 699.

## GLOIOPOTES ORNATUS Wilson.

Plate XVII, figs. 23-34.

*Gloiopotes ornatus* WILSON, 1905, a, p. 127.

*Female*.—Carapace elliptical, about the same length as the rest of the body, considerably longer than wide, strongly arched. Frontal plates well defined, but narrow and without lunules. Posterior sinuses large and well rounded; median lobe less than half the body width, not projecting beyond the lateral lobes, concave posteriorly and somewhat incised at the center.

This lobe enlarges posteriorly until it fills the posterior sinus on either side and overlaps the lateral lobe.

The arrangement of grooves separating the various carapace areas is very complex and constitutes the first important factor in producing the variegated or ornamental appearance of the dorsal surface. Thoracic area large, oblong in general shape, and occupying three-fifths of the width and two-thirds of the length of the carapace. Its lateral grooves have a graceful double curve, while at the center anteriorly is a triangular incision into which fits the posterior end of the eye area. From the apex of this incision a groove extends backward along the median line nearly to the center of the thoracic area, where it divides and sweeps outward toward either side in a broad curve. The thoracic area is thus divided approximately into quarters, each of which is ornamented by various elevations and depressions of the surface.

The eye area is obovate in outline, quite small, and clearly separated from the cerebral area in front, the thoracic area behind, and the lateral areas on either side. The eyes themselves are distinct, situated about in the center of the area, and inclined toward the mid axis. The grooves at the sides of the eye area are prominent and extend forward along either side of the cephalic area of the frontal plates. Numerous smaller grooves branch from those already mentioned and add to the variegated appearance. There is also a row of small spines along either side of the median posterior lobe and a row of long and wavy hairs along the posterior half of the outer margin of the lateral lobes.

The free segment is short and wide and is covered dorsally by two broad plates which extend laterally over most of the basal joints of the fourth legs, and posteriorly over a very little of the genital segment. These plates are smooth and quite transparent along their lateral and posterior margins, but are thrown into numerous folds and wrinkles at the center, where they join each other.

The genital segment is horseshoe-shaped, contracted into a narrow and short neck anteriorly, where it joins the free segment, then widening abruptly to more than half the width of the carapace, and prolonged backward in a stout lobe on either side of the abdomen. The sides of the segment are convex, while the tips of the lobes curve in toward

the abdomen. The dorsal surface of the segment has a few scattered spines on either side at some distance from the mid-line. There is also a row of 5-8 along the center of the lateral margin.

Back of these and at about the centre of the lateral lobes is fastened a triangular flap or membrane, nearly as long as the lobe, quite narrow, and extending diagonally backward and outward.

It is ornamented around its edges with a row of short and stout spines.

The abdomen is cylindrical and two-jointed, the basal joint somewhat wider than the terminal and about half as long.

Near the centre of the terminal joint on the dorsal surface is a large knob, which is ornamented at the sides and above by rows of short spines. The posterior margin of this knob looks like the second joint in the abdomen, but an examination of the ventral surface shows that there is but a single joint.

The anal papillæ are thread-like and about the same length as the terminal joint. They are somewhat broken in all the specimens at command, but did not show any signs of the spines toward their tips, as noticed by Thomson in *Gloiopotes huttoni*. The first antennæ are large, the terminal joint longer than the basal, very narrow, cylindrical, and wholly destitute of setæ. The second antennæ are large and stout, the basal joint considerably flattened and reenforced posteriorly by a short and broad spine, the terminal joint a strong claw with an accessory seta upon its ventral surface.

The first maxillæ are small and three-parted, the two inner prongs shorter and more acute than the outer, which is broad and spatulate. The second maxillæ are short, stout, and bifurcate for more than half their length, the outer branch larger and longer than the inner. These maxillæ are very chitinous and turn dark brown in alcohol, like the tips of the claws and the spines.

The maxillipeds are like those of *Caligus*, the first pair long and slender, the second very large and stout; the basal joint is swollen and nearly twice as long as the slender terminal claw, which latter carries a stout accessory seta on its inner margin.

The furca is compound with bifid branches, between which lies a broad U-shaped sinus; the outer branch extends outward nearly at right angles from the base of the central sinus; the inner branches diverge somewhat; each is enlarged at the tip and subdivided there into two short and blunt knobs. The central foramen has the form of an isosceles triangle, the apex pointing backward.

The swimming legs are very similar to those of *Caligus*; the two inner terminal claws of the first pair are replaced by three-pronged claws, the two ventral prongs being stout, situated side by side, and strongly chitinous, while the dorsal one is slender and remains snowy white even in alcohol (Plate XVII, fig. 31).



The spines on the exopods of the second legs are stout and sharp, and so chitinous that they turn a very deep brown.

The rami of the third legs are close together and each is two-jointed; the endopod is considerably larger than the exopod, unlike the condition in most of the Caligidæ, and is closely appressed to the margin of the basal apron. Indeed this ramus is almost exactly like the two terminal joints of the endopod of the second legs. The exopod, on the contrary, is small and short, but has a large bipartite claw or spine on its basal joint. The fourth legs are large and stout, the basal joint much swollen and considerably longer than the three terminal ones, which are only indistinctly separated. The second joint bears a cluster of short spines on its ventral surface near the base, and a longer and stouter spine at the distal end. All three joints carry a fringe of small teeth along their outer margins. Fifth legs entirely wanting.

Total length, 11 mm.; length of carapace, 5.4 mm.; width of same, 4.6 mm.; length of genital segment, 3.4 mm. (including the spiny appendages); length of abdomen, 3.2 mm.

The egg-strings are a little narrower than the base of the abdomen, but broken so that no idea can be given of their length.

Color (of alcoholic specimens) a uniform yellowish gray without pigment; all the chitinous portions were turned a deep russet brown.

(*ornatus*, ornamented, alluding to the numerous spines and grooves on the dorsal surface).

The species described by Thomson in 1889 as *Lepeophtheirus huttoni* and afterwards rightly transferred by Bassett-Smith (1899) to *Gloio-potes* is very similar to the one here described.

The chief differences lie in the dorsal plates which cover the free segment, in the grooving of the dorsal surface of the carapace, in the fringe of long hair adorning the posterior half of the lateral lobes, and in minor details of the appendages, particularly the first antennæ and the tripartite first maxillæ.

A careful study of the present specimens and their comparison with those described by Thomson suggest forcibly that he did not have a male and female, as he claimed, but rather two females, one with and the other without egg-strings.

The two specimens on which the present species is founded are in the same condition, but they are more nearly alike, and, furthermore, they resemble the one which he designates as a male much more than they do the female. The only sexual differences which he notes consist in a narrowing of the anterior and posterior portions of the body in the female and a diminution in the size of the dorsal plates. Such differences might easily be due to unequal shrinkage, which frequently occurs even with specimens in the same vial, as every investigator who handles preserved material knows only too well.

Furthermore the sexual organs shown in the genital segments of Thomson's "two" sexes are exactly alike, which would be rather an anomaly among the Caligidæ.

The male of *Gloiopotes hygonianus* was described by Stebbing in 1900, and is exactly what would be expected in a genus the females of which show such manifest beginnings of degeneration.

But this male is altogether different from that described by Thomson and adds to the probability that the latter is really an undeveloped female.

This species is founded upon two excellently preserved adult females which were obtained from the outside surface of a swordfish at Woods Hole, Massachusetts. (Cat. No. 6209, U.S.N.M.)

#### Genus ALEBION Kröyer.

The genus *Alebion* was established by Kröyer in 1863 for a single specimen which he claimed was a male and to which he gave the specific name *carchariæ* from its host.

This was sufficiently different from *Caligus* on the one hand and from *Pandarus* on the other to warrant its separation as an intermediate form, and for it Kröyer gave the following diagnosis:

Proboscis intermediate in form between that of the Caliginæ and the Pandarinæ. Palps (second maxillæ) large and stout. Feet of the third (the first thoracic) pair two-branched, the branches biarticulate, the inner one being the smaller. The first, second, and third pairs of thoracic feet armed with corneous bodies of a peculiar form on the laminae of their outer branches. Fourth thoracic legs very rudimentary, uniramous, and two-jointed. Two teeth projecting from the posterior border of the carapace. Sixth thoracic (genital) segment fringed with setæ. Antennal palps, anterior subsidiary hooks (first maxillæ), lunules and furcula lacking.<sup>a</sup>

In 1892 van Beneden described<sup>b</sup> the male and female of a species which he claimed to be the type of a new genus, *Caligera difficilis*. His figures and descriptions are both inaccurate and incomplete, but enough was given to show plainly that he had secured a species of *Alebion*, and it was rightly transferred to that genus by Bassett Smith in 1899.

Bassett-Smith himself found in 1898 what he claimed to be the female of Kröyer's species and gave in the following year these genus characters:

Carapace large, oval. Frontal plates well marked. Anterior antennæ two-jointed. Fourth thoracic segment with small dorsal plates. Genital segment broad, prolonged backward in two elongate processes with the ends and outer margins dentate. Abdomen biarticulate. Caudal plates with long setæ. The first three pairs of thoracic limbs biramous, with lunate corneous bodies on the outer branches; fourth pair of limbs quite rudimentary, hidden.<sup>c</sup>

<sup>a</sup> Bidrag til Kundskab om Snyltekrebsene, 1863, p. 168.

<sup>b</sup> Quelques nouveaux Caligidés de la Côte d'Afrique, et de l'Archipel des Açores, 1892, p. 258. Plate iv. See also p. 367.

<sup>c</sup> A Systematic Description of Parasitic Copepoda found on Fishes, with an Enumeration of the known species, 1899, p. 462.

It is very apparent from an examination of Kröyer's figures and description that his "male" was simply a female without egg-strings, while Bassett-Smith's was a female with egg-strings.

Any attempt, therefore, at sex differentiation between the two is futile. The new species here described with their entire life history, and the true males now for the first time completely differentiated, necessitate many changes in both these generic diagnoses, that of Kröyer being much superior to Bassett-Smith's substitute.

GENERIC DIAGNOSIS.

General form similar to that of *Lepeophtheirus*. Carapace elliptical, much longer than the genital segment. Frontal plates well defined and without lunules. Fourth thoracic (free) segment with small but well-defined dorsal plates in the female; these plates very rudimentary or entirely lacking in the male. Abdomen biarticulate. Anal laminae relatively very large and armed with long setae. First three pairs of thoracic legs two-branched, the exopods armed with stout, strongly curved, corneous claws, much larger than those in other genera. Each branch of the first pair biarticulate; of the other two pairs, triarticulate. Fourth legs rudimentary and invisible from the dorsal surface. Furca lacking, but in its place appear two corrugated chitin ridges arranged like the sides of a V, the apex pointing backward (fig. 18, p. 696). Genital segment enlarged as in the Caliginæ, without any traces of fifth legs. Egg-cases and eggs as in *Caligus*, usually quite long. Development similar to that of the Caliginæ, but in the chalimus stage the young are attached by means of their enlarged second antennæ, and there is no frontal filament.

ANALYTICAL KEY TO SPECIES.

- 1. Genital segment quadrangular, with rounded corners and without posterior processes ..... 2
- 1. Genital segment spindle-shaped or lunate, with conical processes at the posterior corners ..... 4
  - 2. Males; genital segment less than one-third as wide as the carapace; abdomen joints the same width ..... 3
  - 2. Females; genital segment more than half the width of carapace; basal abdomen joint nearly twice as wide as terminal..... *glaber* Wilson, 1905, p. 708
- 3. Genital segment one-fourth longer than abdomen; the two joints of the latter the same length ..... *difficilis* van Beneden, 1892
- 3. Genital segment one-fourth shorter than abdomen; terminal joint of latter nearly twice as long as basal..... *gracilis* Wilson, 1905, p. 704
- 4. Males; posterior processes of genital segment shorter than basal joint of abdomen; fifth legs showing at center of the lateral margins,
  - ..... *glaber* Wilson, 1905, p. 708
- 4. Females; posterior processes of genital segment as long as, or longer than, the entire abdomen; fifth legs not visible dorsally ..... 5

5. Body of genital segment much wider (1.5 to 3 times) than long, with spines on the margins only..... 6
5. Body of genital segment a little longer than wide, the entire dorsal surface and margins covered with spines; dorsal plates small and close together,  
*difficilis* van Beneden, 1892
6. Dorsal plates small and widely separated; genital segment often entirely smooth..... *gracilis* Wilson, 1905, p. 704
6. Dorsal plates of good size and close together, their bases fused; genital segment and processes with a heavy fringe of spines..... *carchariæ* Kröyer, 1863

**ALEBION GRACILIS** <sup>a</sup> Wilson.

Plate XVIII, figs. 35-48.

*Alebion gracile* WILSON, 1905, p. 128.

*Female*.—Carapace elliptical, a little longer than wide, prolonged anteriorly on the mid line over the frontal plates into a blunt rostrum which just reaches the anterior margin of the frontal plates. Posterior sinuses broad, somewhat enlarged at their bases, and dividing the carapace into nearly even thirds.

Both median and lateral lobes squarely truncated. Grooves separating the areas arranged like the letter H as in *Caligus*, but with the sides widely separated, making the lateral areas narrow and the median area very broad.

Free thoracic segment nearly as wide as the genital segment, half as long as wide, and bearing upon its dorsal surface a pair of semilunar plates. These are parallel to the median line and some little distance from it, their convex sides outward and their posterior ends somewhat enlarged and overlapping the genital segment. This latter is a little more than half the width of the carapace, widest at the center, and prolonged posteriorly on either side into a stout conical spine which reaches beyond the anal laminae. The sides of this segment and its posterior projections carry in the fully developed adult a fringe of short spines while at the tips of the projections are three or four longer ones. In immature females these spines at the tips of the projections are the only ones present.

Abdomen two-jointed, the first joint considerably larger than the second, and extending backward on either side of the latter in a blunt conical projection similar to those on the genital segment. The terminal segment is strongly constricted at its junction with the first and is only about half the width of the latter. It bears at its posterior end a pair of anal laminae nearly as long as the segment itself, slightly enlarged at their tips and curved in toward each other. Each lamina carries four long plumose setae.

First antennae two-jointed as in *Caligus*, but not as heavily armed with spines; posterior pair with a large basal joint and a slender, simple terminal claw attached at one side.

<sup>a</sup> For change in gender see p. 707.

Proboscis slender and conical; the chitin framework is quite simple in construction and consists of four longitudinal plates articulated at the base with the ventral surface of the carapace. They taper rapidly toward the tip, where they are articulated with one another in pairs, two on the ventral and two on the dorsal surface. Between these plates are other shorter ones which only reach half the length of the proboscis.

Over this framework is stretched the upper and under lips. The mouth opening is subterminal and horseshoe-shaped, the curve being at the tip of the proboscis, while the sides extend back on the ventral surface alongside the lower lip. The entire opening is heavily fringed with hairs. The mandibles are slender and somewhat spatulate in shape with a row of ten or twelve comb-like teeth on the inner margin at the tip.

The two pairs of maxillæ are reduced to mere semicircular plates, attached in the normal positions but scarcely raised above the ventral surface. The first and second maxillipeds are normal, the terminal claw on the latter being stout and lacking an accessory spine on its inner margin.

The basal joints of the first pair of legs are rather swollen and carry a short and blunt projection at their outer ends on the ventral surface just where the terminal joints are attached.

The exopod is much larger than the endopod, both being two-jointed; the joints are approximately equal in the exopod and the terminal one carries in addition to the regular plumose setæ and spines a large chitinous claw or process which is curved down tightly against the end of the joint. In the endopod the basal joint is about four times the size of the terminal, the latter being nearly spherical and carrying a single large plumose seta on its inner margin. The second and third legs are normal, save that in each the exopod bears upon the ventral surface of its two terminal joints huge chitin claws similar to those upon the first pair. The rami of the third legs are larger than in *Caligus* and project well beyond the basal lamellæ.

The fourth legs are so rudimentary as to be entirely concealed, in a dorsal view, by the sides of the fourth segment, and in a ventral view by the bases of the third legs. By lifting up the latter the stumps of these legs can be seen on the ventral surface of the free segment; they are papillate, one-jointed, and terminate in three short setæ.

The rudimentary fifth legs can also be seen as triangular stumps near the lateral margins of the genital segment, each carrying three short setæ.

The furca is wanting, but in its place is a pair of chitin ridges, between the bases of the first maxillipeds. These start close together on either side of the mid line and run diagonally forward and outward toward the second maxillæ. They are raised considerably from the

ventral surface and are corrugated like a wood rasp. Egg strings as wide as the last joint of the abdomen and nearly as long as the entire body, each containing from sixty to seventy eggs.

Total length, 10 mm.; length of carapace, 5.35 mm.; width of same, 4.9 mm.; length of genital segment, 3.5 mm.; width of same, 2.66 mm.; length of abdomen, 1.67 mm.; length of egg strings, 9 mm.

Color a transparent cartilage gray, exactly like the skin of its shark hosts.

(*gracilis*, slender, graceful.)

*Male*.—The male differs noticeably from the female in the proportion of the body regions. The carapace is orbicular rather than elliptical, being actually wider than long, while the remainder of the body is strongly narrowed, thus making the contrast between the two very striking. The free thorax segment lacks the plates upon its dorsal surface, but carries on either side a rounded, swollen protuberance, looking like the stump of a large fourth leg which had been amputated. The real rudiments of the fourth legs are borne on the ventral surface of these protuberances and are short and very slender.

The genital segment is small and spindle-shaped and has not even a trace of the posterior conical horns found in the female.

The rudiments of the fifth feet are plainly visible on the ventral surface of this segment.

The abdomen is narrow and made up of two spindle-shaped segments of about the same size, the anal laminae are relatively as large as in the female and each terminates in four plumose setae.

The second antennae are used for clasping organs, and are hence much larger and stronger than in the female, and their terminal claws are branched like a stag's horn. There is also a large claw-like spine projecting from the outer margin of the basal joint near its distal end.

The other appendages are like those of the female, except the second thoracic legs, on the exopods of which, in place of the large claws found in the female, there is a long, conical body protruding from the outer margin of the second joint.

From the peculiar structure of these organs in this and the following species it seems probable that they are connected in some way with the transference of semen to the receptacles in the genital segments of the female.

Total length 6 mm. Length of the carapace 3 mm. Width of same 3.2 mm. Length of genital segment 1.25 mm. Width of same 0.9 mm. Length of abdomen 1.4 mm.

Color the same as that of the female.

*Nauplius*.—Body elliptical, much longer than wide, with evenly rounded ends. Eye spot rather large and of a dark brown color; the other pigment lighter, gathered at the posterior end of the body, and shading anteriorly insensibly into the colorless and transparent region,

which latter fills the whole of the anterior half of the nauplius. The three pairs of appendages attached well forward and of the usual shape. The first pair are not carried pointing directly forward side by side as in the *Caliginæ*, but extend outward at the sides of the body like the other two pairs. The balancers are widely separated, elongate, cylindrical throughout, very slender, and they taper to an acuminate point.

Total length 0.3 mm. Width 0.165 mm.

This species is fairly abundant and the United States National Museum collection includes ten lots, as follows: From the head of an unnamed shark fourteen females and four males, taken at Clarion Island and numbered 32724, U.S.N.M. (cotypes). From *Mustelus canis* three females (Cat. No. 8122, U.S.N.M.); one female (Cat. No. 12665, U.S.N.M.); one female (Cat. No. 32725, U.S.N.M.). From *Carcharias littoralis* one female (Cat. No. 6205, U.S.N.M.); two females and a male (Cat. No. 32726, U.S.N.M.). From *Carcharias obscurus* three females (Cat. No. 6083, U.S.N.M.). From a pollack a single female (Cat. No. 12664, U.S.N.M.). From a species of *Trygon* a single female (Cat. No. 6210, U.S.N.M.). From a Bonito one female (Cat. No. 32727, U.S.N.M.).

In 1892 (as stated above, p. 702) van Beneden described "a new genus" belonging to this subfamily which he named *Caligera*, with the species *difficilis*. His figures and descriptions plainly show that the copepod was really an *Alebion*, and accordingly Bassett-Smith in 1899 changed the specific name which Beneden had given in order that it might agree in gender with the name *Alebion*.

For he fell into the error of supposing that this name was neuter in gender because it ended in "on," and hence he made the new name "*Alebion difficile*." The present author made the same mistake without looking up the derivation of the generic name. And the two new species published in 1905 were named respectively "*gracile*" and "*glabrum*." But *Alebion* is the name of one of Neptune's sons, hence masculine in gender.

Beneden's description is not very clear, but the points which he emphasizes are sufficient to distinguish his species from the one here described. In *gracilis* the free segment of the adult female is three-fourths as wide as the genital segment, while its dorsal plates are widely separated even at their bases.

In *difficilis* the free segment is only a little more than half the width of the genital segment and its dorsal plates are close together with their bases fused. But the greatest differences appear in the genital segment; in *difficilis* the body of this segment is longer than wide, while the posterior processes are slender, cylindrical, and parallel. Moreover the entire dorsal and ventral surfaces as well as the margins are covered with a thick coating of spines. But in *gracilis* the body of

the genital segment is one-half wider than long, and its posterior processes are stout, conical, and considerably divergent.

In this species also there are never more than a few scattered spines along the margins of the segment and on its processes, while in many specimens the entire segment is without spines.

There are also numerous minor differences in the detail of the appendages, particularly the mouth parts and the third thorax legs. In the males the chief differences lie in the relative size and shape of the genital segment and abdomen as already brought out in the key on p. 703.

From Kröyer's species, *carcharivæ*, the present form differs in the size and position of the dorsal plates on the free segment, in the size and shape of the genital segment, and in the detail of the appendages. In the female described by Kröyer the dorsal plates on the free segment were close together, their bases fused, with an angular intervening space, and they reached back to the center of the body of the genital segment.

Bassett-Smith says of the female which he described: "In outward form the dorsal plate covering the last thoracic segment was much less apparent."<sup>a</sup> There must have been two of these plates, and the fact that he speaks of them as one would indicate thorough fusion. Here, on the contrary, we find the dorsal plates noticeably distinct to their very bases which are widely separated, while they scarcely overlap the genital segment at all, to say nothing of reaching its center.

Again the female described by Kröyer had a genital segment more than three-fifths as wide as the carapace, and the body of it, exclusive of the processes, is nearly twice as wide as long. In the female described by Bassett-Smith the genital segment was two-thirds the width of the carapace and more than three times as wide as long. But in the present species the genital segment even of a female carrying egg-strings is not half the width of the carapace, and is less than one-third wider than long.

Here again also the genital segment is smooth or has but few setæ, while in *carcharivæ* there is a heavy fringe around the entire margin and along the processes.

#### ALEBION GLABER <sup>b</sup> Wilson.

Plate XIX, figs. 49-61; figs. 17 and 18, pp. 695 and 696.

*Alebion glabrum* WILSON, 1905, p. 129.

*Female*.—Carapace orbicular, squarely truncated posteriorly. Frontal plates well defined. Posterior sinuses broad and deeper than in *gracile*. Longitudinal grooves between the carapace areas widely separated leaving a very broad median area.

<sup>a</sup>Some new or rare Parasitic Copepods found on Fish in the Indo-tropic Region, 1898, p. 367.

<sup>b</sup>For the change in gender, see p. 707.



Free thorax segment nearly as wide as the genital segment, two-fifths as long as wide. Dorsal plates rather small and nearly orbicular, separated by a wide median space.

Genital segment half the width of the carapace, oblong in shape, with nearly parallel sides and well-rounded angles. Its entire margin is smooth and without any trace of the marginal fringe of spines or the posterior prolongations on either side of the abdomen which are present in other species.

Abdomen two-jointed, the joints about the same size; on either side of the first joint a semicircular wing or thin fold of skin projects outward laterally from the dorsal surface, the combined width of the joint and the two wings being about half that of the genital segment. The first abdomen segment has a convex anterior and a concave posterior margin. The terminal segment is slightly spindle-shaped, with comparatively small and elliptical anal laminae. The plumose setae on these laminae are smaller than in other species. The egg-strings are wide and about once and a half the length of the body.

Anterior antennae two-jointed, with the terminal joint much smaller than the basal and strongly club-shaped.

The posterior antennae have a large basal joint with a stout and well-curved terminal claw.

First maxillipeds the same as in all the Caliginæ; second pair large and stout, the terminal claw strong, but not much curved.

On the inner margin of this claw near its tip is a small, flattened flange which extends about a third of the length of the claw. The two pairs of maxillae are similar to those of *gracilis*, but the first pair are even more rudimentary and can be found only with difficulty. The ventral ridges between the bases of the maxillipeds, which take the place of the furca, are similar to those in *gracilis*, but are considerably larger with deeper corrugations.

The basipod of the first pair of legs is rather small, the exopod almost exactly like that of *gracilis* in size, shape, and armature, but the endopod is quite different. Its proximal joint is long with a very wide flange on the inner margin; attached to this flange where it joins the basipod is a small strawberry-shaped papilla. The terminal joint of the endopod carries three setae of equal size as in *carchariae*.

The second legs resemble those of *gracilis* very closely in segmentation and armature, but the joints are relatively smaller.

The third legs present several differences; the exopod is narrow and nearly as long as the endopod; its segments are much longer than wide, thus separating the large claws with which each segment is armed. The endopod is short and stocky and shows its segmentation distinctly. The fourth legs are similar to those of the other species of the genus.

but the fifth legs show a distinct exopod and endopod instead of a single triangular stump, which is exceptional in females.

Total length, 12 mm. Length of carapace, 5.9 mm. Width of same, 6 mm. Length of genital segment, 3.1 mm. Width of same, 3 mm. Length of abdomen, 2.5 mm. Length of egg-strings, 15 mm. Of a grayish horn color, nearly uniform throughout, and not quite as transparent as *gracilis*.

(*glaber*, smooth.)

*Male*.—Carapace distinctly longer than wide and obovate or acorn-shaped, with the widest portion very far back. Posterior sinuses triangular and flaring widely. Free thorax segment long and narrow, less than half the width of the genital segment; dorsal plates so rudimentary as to be indistinguishable.

Genital segment narrow, spindle-shaped, squarely truncated posteriorly, with a conical papilla projecting outward and backward from each corner and terminating in three small spines.

These are the rudiments of the sixth legs, those of the fifth pair appearing at about the center of each side of this genital segment and showing a distinct exopod and endopod.

The abdomen is made up of two nearly equal segments, without the wings, which appear in the female. The anal laminae and their setae are relatively much larger than those in the female.

The second antennae are branched like those in the male of *gracilis*; the other appendages are the same as in the female, except the second legs. Here in place of the large claws upon the exopod we find a pair of curious structures upon the outer distal margin of the second exopod joint. The outer of these is much the larger, conical in shape, nearly as large as the joint itself, and covered with small spherical warts or papillae. The smaller inner one is narrow, cylindrical in form, and two-jointed, the basal joint being four times as long as the terminal, with no peculiarities visible.

Total length, 7.6 mm.; length of carapace, 3.5 mm.; width of same, 3.1 mm.; length of genital segment, 1.25 mm.; width of same, 1.1 mm.; length of abdomen, 1.35 mm.

Color similar to that of the female.

*Metanauplius* (figs. 4-9).—One thorax segment fused with the head to form the carapace, which is spindle-shaped, the two ends about the same size and both emarginate (fig. 4). Eyes very large and situated just in front of the center of the carapace on the mid-line.

Frontal plates distinct, but widely separated and folded over on the ventral surface. Second thorax (first free) segment wider than the rest of the thorax and abdomen, its sides strongly convex. Third segment about the same length as the second, but narrower and its sides not as convex, though still well curved. Fourth and genital segments united with the abdomen into a segment only one-fourth longer than the third segment, with concave sides and well-rounded corners.

Anal laminae short and wide, each bearing four large and one small plumose setae.

First antennae two-jointed, the second joint terminating in very long nonplumose setae, which are dichotomously branched toward their tips. Second antennae much enlarged and curved over ventrally in a half circle. They are the chief organs of prehension and are carried straight forward side by side in front of the carapace.

Second maxillae with distinct endopod and exopod, both of which are bifurcate at their tips. First and second maxillipeds two-jointed and extending well beyond the lateral margins of the carapace. Two pairs of swimming legs, each biramose, the rami one-jointed.

Total length, including second antennae, 1.15 mm.; length of carapace, 0.65 mm.; width of same, 0.32 mm.; width of free segments, 0.15 mm.

Color as in the adult, with pigment spots only along the posterior margin of the carapace and on the abdomen.

*Chalimus* (figs. 10–15).—One thorax segment united with the head to form the carapace, which is elliptical, about one-half longer than wide, the posterior border emarginate. Frontal plates well defined and projecting on either side over the basal joints of the first antennae. Eyes farther forward than in the metanauplius, but still very large. Second and third segments fused *inter se*, the former much wider than the latter.

Fourth and genital segments still fused with the abdomen, but much longer than in the metanauplius and showing a deep constriction on either side. Appendages as before, but each first antenna is now tipped with five short and simple setae; the exopods of the second maxillae are now reduced to papillae on the bases of the endopods, and there are three pairs of swimming legs all biramose and the rami one-jointed.

Total length 2 mm., length of carapace 1 mm.; width of the same 0.7 mm.; width of first free segment 0.55 mm.; of the second, 0.35 mm.

Pigment spots now distributed along the entire length of the lateral margins. Otherwise colored like metanauplius.

This is a large and clean-looking species and must be fairly common since the United States National Museum collection contains the following lots of specimens: From the smooth dog-fish, *Mustelus canis* (Cat. No. 8123, U.S.N.M.), consisting of twelve females and six males, taken as the types; (Cat. No. 32830, U.S.N.M.), a single male; (Cat. No. 32831, U.S.N.M.), three females; (Cat. No. 32832, U.S.N.M.), eight females; 6204, one female from Long Island Sound; 32833, one female; (Cat. Nos. 32834 and 32835, U.S.N.M.), development stages, ten specimens each; (Cat. No. 32836, U.S.N.M.), two females; (Cat. No. 32837, U.S.N.M.), five females. From *Squalus acanthias*, three females, two males; from sand shark, *Eugompodus littoralis*, three females, both by V. N. Edwards, the former 32838, the latter 6102. From barn-

door skate (Cat. No. 32839, U.S.N.M.), eight females; from bonito (Cat. No. 32840, U.S.N.M.), one female.

This species presents a marked contrast to all the other species thus far known in the entire absence of posterior processes on the genital segment of the female. This segment has instead well rounded posterior corners, and there is not a vestige left of the fringe of spines that adorns the margin in other species. In this respect, therefore, the four species form a well-defined series, beginning with *difficilis*, in which the entire genital segment is covered, passing through *carchariæ*, in which there is a heavy fringe along the margins, *gracilis*, in which there are only scattered spines here and there, and ending with *glaber*, in which the spines have entirely disappeared.

There is also a direct antithesis in the relative structure of the genital segment in the two sexes between this species and *gracilis*. In the present species the female has no posterior processes, while the male possesses a pair, although in a considerably reduced form. In *gracilis*, on the contrary, the female has a pair of stout posterior processes, while the male wholly lacks them.

#### Genus DYSGAMUS Steenstrup and Lütken.

(Founded on males only.)

*Generic diagnosis*.—First three thorax segments united with the head to form a large rounded carapace. Frontal plates distinct and prominent; eyes large and in contact with each other on the mid-line. Fourth thorax segment free and without dorsal plates. Genital segment small and evenly rounded, without posterior lobes or rudimentary legs. Abdomen short, two-jointed, with small anal laminae. First antennae two-jointed, joints equal in length; second pair as in *Alebion*. Mouth-tube narrow and conical, longer than in *Euryphorus*, not as long as in *Alebion*. Second maxillae simple, broadly triangular, and slightly curved at the tips; maxillipeds as in *Euryphorus*. All four pairs of legs biramose, the rami two-jointed.

(*dysgamus*, δὲς, badly, and γάμος, wedded, alluding to the fact that no females were found.)

This genus was founded in 1861 by Steenstrup and Lütken upon ten or more male specimens captured at several different places in the Atlantic north of the equator. These males were about the same size (3.5 mm. long), and agreed fully in all essential characters. Bassett-Smith, the only other writer who has mentioned the genus, stated in 1899 that—

This genus was made by Steenstrup and Lütken from a male only; but in the collection of the British Museum there are a large number of specimens, some with external ovaries attached, which I have examined and have no doubt of their identity; therefore the genus is allowed to stand. <sup>a</sup>

<sup>a</sup> A systematic Description of Parasitic Copepoda found on Fishes, with an Enumeration of the known Species, 1899, p. 404.

And on the next page he adds: "Host: 'Shark,' Atlantic and Indian oceans."

This last must have been taken from the labels of the British Museum specimens, for Steenstrup and Lütken distinctly state that their specimens were taken "probably while swimming freely at the surface."<sup>a</sup>

If Bassett-Smith's observation regarding the "large number of specimens, some with external ovaries attached," in the British Museum be correct, there is a probability that the genus is valid. But we can not be certain until the females are described; for the present, therefore, both the original species and the new one here described are to be accepted provisionally.

DYSGAMUS ARIOMMUS, new species.

Plate XX, figs. 62-70.

*Male*.—Carapace 0.6 of the entire length, ovate, considerably widened and squarely truncated posteriorly. Frontal plates prominent and distinct, without lunules, but with a broad and shallow incision at the center. Cephalic area divided by a transverse groove which starts from the lateral groove on either side at a point opposite the eyes, and then divides, one-half passing in front of the eyes and the other half behind them, in the form of two semicircles of different diameters, the posterior one being the smaller. Thoracic area three-fifths of the width of the carapace, but short, with nearly straight and parallel sides; squarely truncated both anteriorly and posteriorly.

Lateral areas narrow and elongate, showing clearly the separation between the head and first thorax segment; posterior lobes, with bluntly-rounded ends just reaching the posterior margin of the thoracic area. The narrow and tapering lateral lobes which extend from the sides of the second segment backward inside of, and parallel to, the carapace lobes are not as completely fused with the latter as usual, but are separated from them by very narrow and slit-like incisions, which extend inward halfway to the anterior margin of the second segment. The tips of these second segment lobes do not quite reach the posterior margin of the third segment, which is considerably narrower than the second.

The lateral lobes of the third segment are broadly triangular and extend diagonally outward and backward over the bases of the third legs. The fourth segment is narrower than the third with prominent and well-rounded sides. Genital segment 0.175 of the entire length, of a plump, barrel shape, with squarely truncated ends; no rudimentary legs visible.

<sup>a</sup> Bidrag til Kundskab om det aabne Havs Snyltekrebs og Lerneer, 1861, p. 368.

Abdomen two-jointed; joints about the same length, the basal one slightly the wider with tapering sides; anal laminae nearly circular in outline, each armed with four long, stout, and densely plumose setae. Anterior antennae two-jointed, joints about the same length, both setiferous; posterior pair rather small, with a stout terminal hook and a curved spine on the posterior margin of the basal joint. No first maxillae; second pair simple flattened spines, broadly triangular, situated at some distance from the mouth-tube on either side, and very far back, nearly opposite the mouth opening.

Mouth-tube narrow and conical, intermediate in form, longer and narrower than in *Gloiopotes* and *Euryphorus*, but not as elongate and pointed as in *Alebiom*. Mouth opening terminal and circular, surrounded with a heavy fringe of hairs. First maxillipeds of the usual pattern; second pair enlarged, the basal joint much swollen, but showing no sign of any protuberance or peg opposite the terminal claw. This latter is slender, strongly curved, and reaches about to the center of the basal joint. All the swimming legs are biramose, rami of the first three pairs two-jointed, of the fourth pair rudimentary and apparently one-jointed, owing to a more or less complete fusion of the joints. Exopod of the first pair several times larger than the endopod, with three huge plumose setae on its posterior border, which are longer than the entire leg.

There are also three good-sized terminal setae and a large spine at the outer corner. The terminal joint of the tiny endopod has also three plumose setae on its posterior border and three spines at the end, while the basal joint carries a single spine on its anterior margin. There is also a large plumose seta on the outer margin of the basal joint of the leg itself, which projects out over the ventral surface of the exopod. Second legs of the usual pattern. Rami of the third legs so near together that their basal joints overlap considerably. Joints of the rami in the fourth legs so fully fused that they appear to be one-jointed, but the arrangement of the setae shows that there are really two joints in each ramus. Fifth legs entirely lacking.

Total length, 3.5 mm.; length of carapace, 2 mm.; of genital segment, 0.57 mm.; of abdomen, 0.43 mm.; width of carapace, 1.92 mm. Color of preserved material yellowish brown, somewhat mottled, and without any visible pigment.

(*ariommu*s, ἀρι, an intensive particle; ὄμμα, eye; hence large-eyed.)

That the present species is distinct from Steenstrup and Lütken's *D. atlanticus* is apparent from the following considerations: The grooves on the dorsal surface of the carapace are arranged very differently, particularly around the eyes. Steenstrup and Lütken make no mention of any eyes either in their description or figures, while in the present species they are large and prominent.

In *atlanticus* the carapace is relatively larger, being nearly six times the width of the free and genital segments; here it is only three times the width of the genital segment and much less than that compared with the free segment.

Furthermore in *atlanticus* the thoracic area is relatively narrow and evenly rounded posteriorly, while here it is much wider and squarely truncated.

In *atlanticus* also the free segment is the same width as the genital segment, while the terminal joint of the abdomen is several times larger than the basal. In the present species the free segment projects considerably over the bases of the fourth legs, and the abdomen joints are of the same size.

Specific differences may also be noted in the structure of the second antennæ, the second maxillipeds, the furca, and the four pairs of swimming legs, particularly the fourth pair, which are small and somewhat rudimentary in the present species.

Here also these fourth legs are connected across the mid-line like the three preceding pairs. Whether the same condition obtains in *atlanticus* is not stated, but it furnishes a characteristic which is quite distinct from other closely allied genera.

Although there is but a single specimen of this species it is well differentiated and proves to be of considerable morphological importance, for it helps to settle the exact relation of the different carapace areas in these three subfamilies, the Caliginæ, the Trebinæ, and the Euryphorinæ. In them, two, and usually three, of the anterior thorax segments are fused with the head, and there has been considerable discussion by various authors as to the morphological significance of the different portions of the carapace. A careful study of the carapace of the present species, compared with that of the three species of *Trebius* already described, and also with that of a mature chalmus of *Lepeophtheirus nordmannii*, recently obtained by the author from the United States Bureau of Fisheries, leaves little chance for further doubt. It will be seen in fig. 19 that the carapace of the present species is divided transversely by three grooves. The anterior of these (*a*) separates the frontal plates from the carapace;

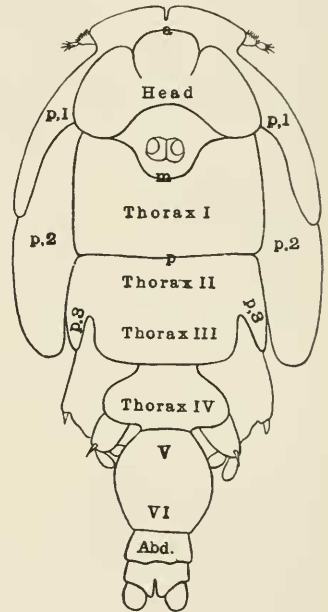


FIG. 19.—THE DORSAL SURFACE OF A MALE *DYSGAMUS ARIOMMUS*, SHOWING AREAS AND SEGMENTS. *a*, ANTERIOR; *m*, MEDIAN, AND *p*, POSTERIOR TRANSVERSE GROOVES. *p*, 1, *p*, 2, AND *p*, 3, LATERAL LOBES OF THE HEAD, FIRST AND SECOND THORAX SEGMENTS RESPECTIVELY.

the middle one (*m*) is the dividing line between the head and the first thorax segment, while the posterior one (*p*) separates the first from the second thorax segments. There is no visible groove here between the second and third thorax segments, but in *Trebius* (Plate XV, figs. 1 and 2) we find that it joins the posterior sinuses of the carapace and is approximately parallel with the other transverse grooves.

The middle groove is extended outward and backward across the lateral area on either side to the edge of the carapace, where it makes a notch similar to that left by the corresponding groove in *Trebius*. In the three species of this latter genus it can be seen that the portion of the lateral grooves which lies behind the crossbar of the "H" is really a part of that crossbar groove in that it completes the separation of the second thorax segment from the first. We are thus enabled to see distinctly that the anterior and outer portion of the lateral areas (*P*, 1) is really a sort of lateral lobe or process belonging to the head. The remainder of the lateral areas is similarly seen to be a process or lobe (*P*, 2) of the first thorax segment. In like manner that portion of each posterior lobe of the carapace which is inside of the longitudinal groove (*P*, 3) represents a lateral process or lobe of the second thorax segment. Neither the third nor the fourth thorax segments have any lateral processes.

Like the original specimens of *atlanticus* the single representative of this species was taken while swimming freely at the surface during the voyage of the United States Bureau of Fisheries steamer *Albatross* in 1887-88. It is Cat. No. 32728, U.S.N.M. This genus *Dysganus* was placed by the author among the Caliginæ in a key given in a previous paper.<sup>a</sup> That, however, was before the present specimen had been obtained and studied. The genus evidently belongs with the Euryphorinæ where it was placed by Gerstaecker, as is shown by the description and figures here given, but we must have a description of the female before this matter can be finally settled.

#### Genus DISSONUS Wilson.

*Generic diagnosis*.—Only the first thorax segment fused with the head to form a carapace, which is semilunar in shape and about twice as wide as long. Second, third, and fourth segments free, each considerably wider than long, the second one only provided with lateral plates. Genital segment not much enlarged, without plates or processes, but with the entire ventral surface sparsely covered with spines. Abdomen small, nearly as wide as long; anal laminae of medium size and armed with large plumose setae. Egg-strings four-fifths the entire length; eggs large, about 40 in each string. Antennae and mouth-parts similar to those in the Caliginæ and not at all like those in the

<sup>a</sup> Proc. U. S. Nat. Mus., XXVIII, 1905, p. 533.



Pandarinae. Second maxillae bifurcate at the tip; first maxillae and furca wanting. All four pairs of swimming legs biramous; rami of the first pair two-jointed, of the other pairs three-jointed; jointing, spines, and setae almost exactly like those in *Trebina*.

(*dissonus*, disagreeing or different; i. e., a connecting link which does not agree with any of the established subfamilies.)

#### DISSONUS SPINIFER Wilson

Plate XX, figs. 71-72.

*Dissonus spinifer* WILSON, 1906, p. 198, pl. III, figs. 34-47.

*Female*.—Carapace transversely semilunar, twice as wide as long; dorsal surface with but a single pair of grooves, separating the lateral areas from the cephalic. Eyes moderately large, close to the anterior margin; in contact with each other on the mid-line, but not fused. A pair of elliptical spots in front of the eyes raised like lenses. Second, third, and fourth segments diminishing regularly in size; second segment as wide as the carapace and its lateral plates as wide as the lateral lobes of the carapace. Third and fourth segments considerably narrowed, but even the fourth twice as wide as long. Genital segment quadrangular, a little wider than long and a little narrower than the fourth segment; posterior processes small, fifth legs invisible dorsally. Abdomen three-eighths the length of the genital segment, one-fourth wider than long, with a shallow anal fissure. Anal laminae quadrangular, each with four large plumose setae, three of which are terminal, while the other comes out of the lateral margin near the anterior end.

The two pairs of antennae like those of *Caligus*; first maxilla and furca entirely lacking; mandibles slender, three-jointed, toothed on the inner margin near the tip.

Mouth-tube triangular with a narrow tip; mouth-opening terminal and heavily fringed with hairs. Second maxillae large and powerful, reaching well beyond the tip of the mouth-tube; basal portion enlarged and flattened, bearing the rudimentary exopod; endopod triangular and curved, bifurcate at the tip, the outer branch a little the larger and longer. The two pairs of maxillipeds of the usual pattern, the basal joint of the second pair with a stout corrugated knob against which shuts the tip of the terminal claw. In the first pair of swimming legs the exopod is a little more than twice the length of the endopod, and its basal joint is three times as long as the terminal. The endopod joints are about the same size. The other swimming legs as in the *Trebinae* and other *Euryphorinae*, the fifth pair as small papillae, each armed with three setae.

Cement glands small, broadly club-shaped, and reaching but little in front of the center of the genital segment.

Total length, 3 mm.; length of carapace, 0.85 mm.; of free thorax, 1.1 mm.; of genital segment, 0.71 mm.; of abdomen, 0.34 mm.; of egg-strings, 2.35 mm.; width of carapace, 1.75 mm.

*Male*.—Similar to the female in general appearance and in most of the details of structure. Genital segment elongate spindle-shaped, one-third longer than wide, with evenly rounded sides; anterior margin reentrant, posterior one nearly squarely truncated.

Both the fifth and sixth legs visible, the former on the lateral margins, the latter at the posterior corners. Abdomen not as wide as in the female, and the anal laminae a little smaller.

Second antennae especially large and stout, the terminal claw bearing on its inner margin a long curved spine, a short blunt one, and a long slender hair. Second maxillae larger and more powerful than in the female, the outer branch at the tip nearly twice as long as the inner one. Spines on the ventral surface of the genital segment larger and more numerous than in the female.

Total length, 3 mm. Length of carapace, 0.8 mm.; of free segments, 1.08 mm.; of genital segment, 0.8 mm.; width of carapace, 1.9 mm.

Color of the two sexes (preserved material) the same, a uniform yellowish white without pigment.

(*spinifer*, *spina*, a spine; and *fero*, I bear).

Through the courtesy of Prof. W. A. Herdman, of the University of Liverpool, the collection of the United States National Museum contains a specimen of each sex of this new genus, Cat. No. 32729, U.S.N.M.

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## EXPLANATION OF THE PLATES.

PLATE XV.—*Trebius exilis*, Wilson, and *T. tenuifurcatus* Rathbun.

- Fig. 1. *Trebius exilis*, dorsal view of female.  
 2. Dorsal view of male.  
 3. Second antenna and first maxilla of female.  
 4. Second antenna of male.  
 5. Mouth tube and second maxilla.  
 6. Furca.  
 7. Fourth swimming leg.  
 8. *Trebius tenuifurcatus*, dorsal view of female.  
 9. Second antenna and first maxilla.  
 10. Furca.  
 11. Second antenna and first maxilla of *Trebius caudatus* Kröyer.  
 12. Mouth tube and second maxilla of same.  
 13. Furca.

PLATE XVI.—*Trebius caudatus* Kröyer.

- Fig. 14. Dorsal view of female.  
 15. Dorsal view of male.  
 16. First maxilliped.  
 17. Second maxilliped.  
 18-21. First, second, third, and fourth swimming legs.  
 22. Ventral view of genital segment of female.

PLATE XVII.—*Gloiopotes ornatus* Wilson.

- Fig. 23. Dorsal view of female.  
 24. Second antenna.  
 25. First maxilla.  
 26. Second maxilla.  
 27. First maxilliped.  
 28. Second maxilliped.  
 29. Furca.  
 30-34. First, second, third, and fourth swimming legs.  
 31. Three-parted spine on the first leg, magnified.

PLATE XVIII.—*Alebion gracilis* Wilson.

- Fig. 35. Dorsal view of female.  
 36. Dorsal view of male.  
 37. Second antenna of female.  
 38. Second antenna of male.  
 39. Second antennae, mouth tube, and second maxillæ of female, showing relation of the parts.  
 40. Dorsal view of mouth tube, enlarged.  
 41. Ventral view of tip of same, showing opening.  
 42. Mandible.  
 43. First maxilliped.  
 44. Second maxilliped.  
 45-47. First, second, and third swimming legs.  
 48. Ventral view of genital-segment of female.

PLATE XIX.—*Alebion glaber* Wilson.

- Fig. 49. Dorsal view of male.  
 50. Dorsal view of female.  
 51. Second antenna of female.  
 52. Mouth tube, second maxillæ, and chitin pads.  
 53. First maxilliped.  
 54. Second maxilliped.  
 55-58. First, second, third, and fourth swimming legs.  
 59. Rudimentary fifth legs, greatly enlarged.  
 60. Ventral view of genital segment of female with spermatophores in place.  
 61. Ventral surface of genital segment of male, showing rudiments of both fifth and sixth swimming legs, and a partial separation of the sixth thorax segment.

PLATE XX.—*Dysgamus ariommus*, new species; and *Dissonus spinifer* Wilson.

- Fig. 62. Dorsal view of male of *Dysgamus ariommus*.  
 63. Second antenna.  
 64. Mouth tube and second maxillæ.  
 65. Second maxilliped.  
 66. Furca.  
 67-70. First, second, third, and fourth swimming legs.  
 71. Dorsal view of female of *Dissonus spinifer*.  
 72. Dorsal view of male.